1548

PROPOSALS

For Printing by SUBSCRIPTION,

THE INSTRUCTIONS

GIVEN IN THE

DRAWING SCHOOLS

ESTABLISHED IN

ENGLAND, SCOTLAND, and other Parts of EUROPE.

To enable the Youth of thoſe Countries to become Proficients in the different Branches of that Art, and to purſue with Succeſs *Geographical*, *Nautical*, *Mechanical*, *Commercial*, and *Military Studies*.

Quid munus reipublicæ majus meliuſve afferre
Poſſumus, quam ſi juventutem bene erudiamus? CICERO.

BY JOSEPH FENN,

Teacher of the Mathematicks.

DUBLIN:

Printed by GEORGE CECIL. MDCCLXVII.

CONDITIONS.

I. THAT theſe Inſtructions ſhall be printed in Octavo, in the Order of the Plans annexed, on a fine Medium Paper, and the Copper-Plates to be engraved by the beſt Maſters.

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Five Shillings and Five Pence, in Part, for a Volume of the *Elements of Euclid*, digeſted in a methodical Order.

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Con

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TO THE

Right Honourable and Honourable

The MEMBERS of the DUBLIN SOCIETY

ARE PRESENTED

The PLANS of INSTRUCTION adopted in the DRAWING-SCHOOLS eſtabliſhed in *England*, *Scotland*, and in other Parts of Europe,

Whcih are now propoſed to be put in Execution by JOSEPH FENN, heretofore Profeſſor of Philoſophy in the Univerſity of *Nantes*, if he ſhould be appointed by the SOCIETY to co-operate with the Drawing-Maſters penſioned by them; thereby to enable the Youth of this Kingdom to become proficients in the different Branches of that Art, and to purſue with Succeſs, Geographical, Nautical, Mechanical, Commercial, or Military Studies.

N. B. Such young Gentlemen, whoſe Parents chuſe they ſhould be inſtructed in any of ſaid Branches, are attended on in the Ground Floor of No. 8 of the College.

L'Oiſivete & l' Ignorance ſont les deux Sources empoiſonnes de tous les Deſordres, & les plus grands Fleaux de la Societe.

MONTESQUIEU.

THE Education of Youth is conſidered in all Countries as the Object which intereſts moſt immediately the Happineſs of Families, as well as that of the State. To this End, the ableſt hands are employed in forming Plans of Inſtruction, the beſt calculated for the various Profeſſions of Life, and Societies are formed, compoſed of Men diſtinguiſhed, as well by their Birth and Rank, as by their Experience and Knowledge, under whoſe Inſpection, and by whoſe Care they are carried into Execution, by Perſons of acknowledged Abilities in their different Departments: And thus the Education of Youth is conducted, from their earlieſt Years, in a Manner the beſt ſuited to engage their Minds in the love of uſeful Knowledge, to im-

prove their Underſtandings, to form their Taſte and ripen their Judgments, to fix in them an Habit of Thinking with Steadineſs and Attention, to promote their Addreſs and Penetration, and to raiſe their Ambition to excel in their reſpective Provinces.

However neceſſary ſuch Regulations may appear to every reaſonable Perſon, however wiſhed for by every Parent who feels the Loſs of a proper Education in his own Practice; nevertheleſs they have not been even thought of in this Country, where that extent of Knowledge, requiſite to prepare Youth either to appear with dignity in the various employments of Life, or to enable them to bring to Perfection the different Arts for which they are deſigned, being not attended to; Education is regarded as a puerile Object, and of Courſe from the illiberal and mechanical Methods of teaching made uſe of, Youth receive little or no Information.

To remove ſo general and well-grounded a Complaint it is propoſed to open to the Youth of this Kingdom, under the Inſpection of the DUBLIN SOCIETY, a new Scene of uſeful and agreeable Knowledge, calculated for all Stations in life. The Author of it imagining that he could not better promote the Views of the DUBLIN SOCIETY, for the Public Good, than by extending to Naval, Civil, and Military Purpoſes, a Drawing-School, hitherto meerly confined to the teaching to draw or deſign Heads and Patterns, than by chooſing them the Preſidents, in whoſe Preſence the Connoiſſeurs and the moſt celebrated Artiſts, devoting their Attention to excite the Emulation of the Pupils would adjudge and diſtribute the Premiums granted to engage them to advance more and more their Studies towards the Point of Perfection; and in fine, than by recommending to their Partronage ſuch young Perſons, favoured by Nature more than by Fortune, who ſhall diſcover happy Diſpoſitions, and ſuperior Talents, for the Service of their Country.

At a Time, therefore, when the Honourable Members propoſe to take into Conſideration the moſt effectual Means of rendering the Talents of the Drawing-Maſters, penſioned by the Society, uſeful to the Public, it is preſumed they will favourably receive the moſt approved Plans of Inſtruction, adapted to every Rank and Condition, and the Offer that has been made of putting them in execution by a Perſon of unexceptionable Character and acknowledged Abilities, as will appear upon a fair Examination before impartial and unprejudiced Judges.

The

The PLANS are as follow.

I.

PLAN of a Courſe of pure Mathematicks, abſolutely neceſſary for the right Underſtanding any Branches of practical Mathematicks in their Application to Geographical, Nautical, Mechanical, Commercial, and Military Enquiries.

II.

PLAN of the Phyſical and moral Syſtem of the World, including the Inſtructions relative to young Noblemen and Gentlemen of Fortune.

III.

PLAN of the Military Art, including the Inſtructions relative to Engineers, Gentlemen of the Artillery, and, in general, to all Land Officers.

IV

PLAN of the Merchantile Arts, or the Inſtructions relative to thoſe who are intended for Trade.

V.

PLAN of the Naval Art, including the Inſtructions relative to Ship Builders, Sea Officers, and to all thoſe concerned in the Buſineſs of the Sea.

VI.

PLAN of the School of Mechanic Arts, under the Direction of the Royal Academy of Sciences at Paris, where all Artiſts, ſuch as Architects, Painters, Sculptors, Engravers, &c. Clockmakers, Jewellers, Goldſmiths, &c. receive the inſtructions in Geometry, Perſpective, Staticks, Dynamicks, Phyſicks, &c. which ſuit their reſpective Profeſſions, and may contribute to improve their Taſte and their Talents.

Thoſe Plans will ſufficiently convince the Honourable Members that their Children, and, in general, the Youth of this Country, are deſtitute of the moſt important Means of Inſtruction, and will ever be deſtitute of them, until able Teachers be encouraged by the SOCIETY.

PLAN of a Courſe of pure Mathematicks, abſolutely neceſſary for the right underſtanding any Branch of practical Mathematicks in their application to Geographical, Nautical, Mechanical, Commercial, and Military Enquiries.

Vix quicquam in univerſa Matheſi ita dificile aut arduum occurrere poſſe, quo non inoffenſo Pede per hanc Methodum penetrare liceat.

PURE Mathematicks comprehend Arithmetick, and Geometry. Practical Mathematicks, their application to particular Objects, as the Laws of Equilibrium, and Motion of ſolid and fluid Bodies, the Motion of the Heavenly Bodies, &c. they extend to all Branches of Human Knowledge and ſtrengthening our intellectual Powers, by forming in the Mind an Habit of Thinking Cloſely, and Reaſoning Accurately, ſerve to bring to perfection, with an entire Certitude, all Arts, which Man can acquire by his Reaſon alone. It is therefore of the higheſt Importance, that the Youth * of this Country ſhould be methodically brought acquainted with a Courſe of pure Mathematicks to ſerve as an Introduction to ſuch Branches of Knowledge, as are requiſite to qualify them for their future Stations in Life. And the Honourable Members, always attentive to what may contribute to the Publick Good, will, without doubt, favourably receive the Offer that has been made of putting this Plan in execution, in the Drawing-School eſtabliſhed under their inſpection, by a Perſon who, on account of the readineſs and Knowledge he has acquired in theſe matters, during the many Years that he has made them his principal Occupation, is qualified for making the entry to thoſe abſtruſe Sciences acceſſable to the meaneſt Capacity.

The Method of teaching Mathematicks.

The Uſe of Syntheſis in Mathematicks is neceſſary to diſcover the principal properties of Geometrical Figures, which cannot be rightly deduced but from their Formation, and Suits Beginners, who, little accuſtomed to what demands a ſerious Attention, ſtand in Need of having their Imagination helped by ſenſible Objects ſuch as Figures, and

* The proper Age to commence this Courſe is 14.

and by a certain detail in the Demonſtrations, but ought not to extend farther than the ſimple Elements, * when applyed to any other reſearch, it attains its point, but after many windings and perplexing Circuits, *viz.* by multiplying Figures, by deſcribing a vaſt many Lines and Arches, whoſe Poſition and Angles are carefully to be obſerved, and by drawing from theſe Operations a great number of incidental Propoſitions which are ſo many Acceſſaries to the Subject. The Works of the Ancients, and the Synthetical Part of the Treatiſe of Fluxions of Mc. Laurin are evident Inſtances of what is advanced here. Very few have Courage enough, even are capable of ſo earneſt an Application, as is neceſſary to follow the Thread of ſuch complicated Demonſtrations; and as it is the only Road leading to Mathematical Knowledge that has been opened in this Country, it has retarded the Progreſs the Study of this Branch of Learning otherwiſe would have made, if a Method more eaſy, and which fatigues leſs the Attention, was introduced: This Method is the Analitic Art, the ingenious Artifice of reducing Problems to the moſt ſimple and eaſieſt Calculations, that the Queſtion propoſed can admit of, it is the univerſal Key of Mathematicks, and has opened the Door to a great number of Perſons to whom it would be ever ſhut without its help; by its means Art ſupplies Genius, and Genius, aided by an Art ſo uſeful, has had ſucceſſes that it would never have obtained by its own Force alone, it is by it that the Theory of curve Lines have been unfolded, and have been diſtributed in different Orders, Claſſes, Genders, and Species, which as in an Arſenal, where Arms are properly arranged, puts us in a State of chuſing readily thoſe which ſerve in the Reſolution of a Problem propoſed, either in Mechanicks, Aſtronomy, Opticks, &c. it is it which has conducted the great *Sir Iſaac Newton* to the wonderful Diſcoveries he has made, and enabled the Men of Genius, who have come after him, to improve them: the Method of Fluxions, both direct and inverſe, is only an extention of it, the firſt being the Art of finding Magnitudes infinitely ſmall, which are the Elements of finite Magnitudes: the ſecond the Art of finding again, by the means of Magnitudes infinitely ſmall, the finite quantities to which they belong: the firſt as it were reſolves a Quantity, the laſt reſtores it to its firſt State; but what one reſolves, the other does not always reinſtate, and it is only by analitic Artifices that it has been brought to any degree of perfection, and perhaps in Time will be rendered univerſal, and at the ſame Time more ſimple. What cannot we expect, in this reſpect, from the united and conſtant Application of the firſt Mathematicians in Europe, who, not content to make uſe of this ſublime

* For the Method of teaching the Elements, ſee the ſpecimen.

ſublime Art, in all their diſcoveries, have perfected the Art itſelf, and continue ſo to do.

This Method has alſo the Advantage to be cleat and evident, and the Brevity that accompanies it every where does not require too ſtrong an Attention. A few Years moderate Study ſuffice to raiſe, a Perſon of ſome Talents, above theſe Geniuſes who were the Admiration of Antiquity; and we have ſeen a young Man of ſixteen publiſh a Work, (*'Traite' des Courbes a double Courbure par Clairaut*) that Archimedes would have wiſhed to have compoſed at the End of his Days. an able Teacher of Mathematicks is therefore much wanting in this Kingdom, who has made it his Buſineſs to ſtudy the different Pieces upon the Analitic Art, diſperſed in the Works of the moſt eminent Mathematicians, make a judicious Choice of the moſt general and eſſential Methods, and lead his Pupils, as it were, by the Hand in the intricate Roads of the Labyrinth of Calculation: by this Means Beginners, exempted from that cloſe Attention of Mind, which would give them a Diſtaſte for a Science they would be deſirous to attain, and Methodically brought acquainted with all its preliminary Principals, would be enabled in a ſhort Time, not only to underſtand the Writings of the moſt eminent Mathematicians, but, reflecting on their Method of proceeding, to make Diſcoveries honourable to themſelves and uſeful to the Publick.

ARITHMETICK.

Arithmetick comprehends the Art of Numbering and Algebra, conſequently is diſtinguiſhed into particular and univerſal Arithmetick, becauſe the Demonſtrations which are made by Algebra are general, and nothing can be proved by Numbers but by Induction. The Nature, Formation, and Calculation of Numbers are clearly to be ſtated, from whence the manner of performing the principal Operations, as Addition, Subſtraction, Multiplication, and Diviſion, will eaſily be deduced. The Explication of the Signs and Symbols uſed in Algebra ſhould follow, and the Method of reducing, adding, ſubtracting, multiplying, dividing, Algebraic Quantities ſimple and compound. This will prepare the Way for the Theory of Vulgar, Algebraical, and Decimal Fractions, where the Nature, Value, Manner of comparing them, and their Operations, are carefully to be unfolded. The Compoſition and Reſolution of Quantities comes after, including the Method of raiſing Quantities to any Power, extracting of Roots, the manner of performing upon Roots of imperfect Powers,

Radical

Radical or Incommenſurable Quantities, the various Operations of which they are ſuſceptible. The Compoſition and Reſolution of Quantities being finiſhed, the Doctrine of Equations preſents itſelf next, where their Geneſis, the Nature and Number of their Roots, the different Reductions and Transformations that are in uſe, the manner of ſolving them, and the Rules imagined for this Purpoſe, ſuch as Tranſpoſition, Multiplication, Diviſion, Subſtitution, and the Extraction of their Roots, are accurately to be treated. After having conſidered Quantities in themſelves, it remains to examine their Relations; this Doctrine comprehends Arithmetical and Geometrical Ratios, Proportions and Progreſſions, and ſhould be terminated by the compleat Solution of this general Problem, in any Arithmetical or Geometrical Progreſſion, three of the following Quantities, *viz.* 1*ſt.* the firſt Term; 2*d.* the laſt Term; 3*d.* the common Difference or Quotient; 4*th.* the Number of Terms; 5*th.* the Sum of all the Terms being given to find the two others: the Theory of Series ſhould follow, where their Formation, Method of diſcovering their Convergency, or Divergency, the Operations of which they are ſuſceptible, their Reverſion, Summation, their Uſe in the Inveſtigation of the Roots of Equations, Conſtruction of Logarithms, &c. ſhould be taught: in fine the Art of Combinations, and its Application for determining the Degrees of Probability in Civil, Moral, and Political Matters ſhould be diſcloſed. *Ars* (to uſe the Expreſſions of the great *Monteſquieu*) *cujus Uſus et Neceſſitas ita univerſale eſt, ut ſine illa, nec Sapientia Philoſophi, nec Hiſtorici Exactitudo, nec Medici Dexteritas, aut Politici Prudentia, conſiſtere queat. Omnis enim horum Labor in cogitando, et omnis Conjectura in Trutinandis Cauſarum Complexionibus aut Combinationibus verſatur.*

GEOMETRY.

Geometry is divided into Elementary, Tranſcendental, and Sublime.

ELEMENTARY GEOMETRY.

The natural Diviſion of Elementary Geometry is into Geometry of right Lines and Circles, Geometry of Surfaces, Geometry of Solids, Trigonometry plain and Spherical.

Tho' a right Line is ſimpler than a Circle, it is neceſſary to treat of both together, and not ſeperately, becauſe the Properties of the Circle are of vaſt Uſe to demonſtrate, after a ſimple and eaſy manner, what

what regards right Lines compared with another as to their Poſition. The ſimple Propoſition that an Angle is meaſured by the Arch, included between its Sides, deſcribed from its Summit as a Center, joined to the Principal of Superpoſition, are ſufficient to demonſtrate all the Propoſitions that relate to the Geometry of Lines.

After having treated of the Geometry of Lines conſidered relative to their Poſition, the Geometry of Lines conſidered as to the Ratio they may bear to one another follows. It is founded on this Propoſition that a Line, Parallel to the Baſe of a Triangle, cuts its Sides proportionally.

The Geometry of Surfaces conſiſts in their Meaſure, and this Meaſure is founded on one Principle, that of the Meaſure of a right Angled Parallellogram. The ſame Method is to be followed in the Geometry of Solids, as in that of Surfaces, the whole is to be reduced to the Meaſure of a right Angled Parallelipipede, making uſe of the Method of exhauſtions reduced to that of infinitely ſmall Quantities. After having ſhewed the Identity of thoſe two Principles, remarking that the firſt is only a ſhort Way of Expreſſing the ſecond; by this means the facility of the Demonſtrations will be greater without loſeing any thing of their Rigour.

Trigonometry, plain and Spherical, conſiſts in the compleat Solution of this general Problem, three of any of the ſix Parts of a Rectilinear or Spherical Triangle being given to find the three others.

TRANSCENDENTAL GEOMETRY.

This Geometry preſuppoſes the Algebraic Calculation; it ſhould commence by the Solution of the Problems of the ſecond Degree by means of the right Line and Circle: this Theory will produce important and curious Remarks upon the poſitive and negative Roots, upon the Poſition of the Lines which expreſs them upon the different Solutions that a Problem is ſuſceptable of; from thence we ſhould paſs to the general Principles of the Application of Algebra to curve Lines, which conſiſt, *viz.* 1*ſt.* in explaining how the Relation between the Ordinates and Abſciſſes of a Curve is repreſented by an Equation: 2*d.* how by ſolving this Equation we diſcover the Courſe of the Curve, its different Branches, and its Aſſimplots: 3*d.* the manner of finding by the direct Method of Fluxions, the Tangents, the Points of Maxima, and Maxima: 4*th.* teaching how the Areas of Curves are found by the inverſe Method of Fluxions.

The

The Conic Sections ſhould follow, the beſt Method of treating them is to conſider them as Lines of the ſecond Order, to divide them into their Species. When the moſt Simple Equations of the Parabola, Eliſes, and Hipperbola are found, then it will be eaſily ſhewn that theſe Curves are generated in the Cone. The Conic Sections ſhould be terminated by the Solution of the Problems of the third and fourth Degree, by the Means of theſe Curves.

The Conic Sections being finiſhed, we ſhould paſs to Curves of a ſuperior Order, beginning by the Theory of Multiple Points, of Points of Inflection, Points of contrary Inflection of Serpentment. Theſe Theories are founded partly upon the Simple Algebraic calculation, and partly on the direct Method of Fluxtions. Then comes the Theory of the Evolute and Cauſtiques by Reflection and Refraction. We ſhould afterwards enter into a Detail of the Curves of different Orders, aſſigning their Claſſes, Species, and principal Properties, treating more amply of the beſt known, as the Folium, the Conchoide, the Ciſſoide, *&c.*

The Mechanic Curves ſhould follow the Geometrical ones, beginning by the Exponentical Curves, which are a mean Species between the Geometrical Curves, and the Mechanical ones, afterwards having laid down the General Principles of the Conſtruction of Mechanic Curves, by the Means of their Fluxional Equations, and the Quadrature of Curves, we ſhould enter into the detail of the beſt known, as the Spirial, the Quadratrice, the Cycloide, the Trochoide, *&c.*

SUBLIME GEOMETRY.

THIS Geometry comprehends the Inverſe Method of Fluxions, and its Application to the Quadrature, and Rectification of Curves, the Cubing of Solids, *&c.*

Fluxional Quantities, involve one or more variable Quantities, the Natural Diviſion therefore of the Inverſe Method of Fluxions is into the Method of finding the Fluents of Fluxionary Quantities, containing one variable Quantity, or involving two or more variable Quantities; the Rule for finding the Fluents of Fluxional Quantities, of the moſt Simple Form, is firſt to be laid down, then applied to different Caſes, which are more compoſed, and the Difficulties which ſome Times occur, and which embarraſs Beginners, are to be ſolved.

Theſe Reſearches will prepare the Way for finding the Fluents of Fluxional Binomials, and Trinomicals, Rational Fractions, and ſuch Fluxional Quantities as can be reduced to the Form of Rational

Fractions; from thence we ſhould paſs to the Method of finding the Fluents of ſuch Fluxional Quantities which ſuppoſe the Rectification of the Elipſes and Hipperbola, as well as the Fluxional Quantities, whoſe Fluents depend of the Quadrature of the Curves of the third Order; in fine, the reſearches which Mr. *Newton* has given in his Quadrature of Curves, relative to the Quadrature of Curves, whoſe Equations are compoſed of three or four Terms; and this firſt Part ſhould be terminated by the Methods of finding the Fluents of Fluxional, Logarithmetical, and Exponentical Quantities, and thoſe which are affected with many Signs of Integration, and the various Methods of Approximations, for the Solution of Problems, which can be reduced to the Quadrature of Curves.

The ſecond Part of the Inverſe Method of Fluxions, which Treats of Fluxional Quantities, including two or more variable Quantities, ſhould commence by ſhewing how to find the Fluents of ſuch Fluxional Quantities which require no previous Preparation; the Methods for knowing and diſtinguiſhing theſe Quantities or Equations; afterwards we ſhould paſs to the Methods of finding the Fluents of Fluxional Quantities, which have need of being prepared by ſome particular Operation, and as this Operation conſiſts moſt commonly in ſeperating the Indeterminate Quantities, after having taught how to conſtruct Differential Equations, in which the Indeterminate Quantities are ſeparated, we ſhould enter into the Detail of the different Methods for ſeparating the variable Quantities in a propoſed Equation, either by Multiplications, Diviſions, or Transformations, ſhewing their Application; firſt, to homogenious Equations, and after having taught how to conſtruct theſe Equations in all Caſes, the Manner of reducing Equations to their Form is to be then unfolded. How the Method of indeterminate Coeficients can be employed for finding the Fluents of fluxional Equations, including a certain Number of variable Quantities, and how by this Method, the Fluent can be determined by certain Conditions given of a fluxional Equation. Fluxional Quantities of different Orders follow, it ſhould be ſhewn, firſt, that Fluxional Equations of the third Order, have three Fluents of the ſecond Order, but the laſt Fluent of a Fluxionary Equation of any Order is Simple, then the various Methods imagined by the moſt eminent Mathematicians for finding theſe Fluents, ſuppoſing the Fluxion of any one variable Quantity conſtant ſhould be explained, and the whole in fine terminated by the Application of this Doctrine to the Quadrature and Rectification of Curves, Cubing of Solids, *&c.*

CONCLUSION.

CONCLUSION.

Such is the Plan of a Courſe of pure Mathematicks traced by *Newton*, improved by *Cotes*, *Bernoully*, *Euler*, *Clairaut*, *D'Lambert*, *McLaurin*, *Simpſon*, *Fontain*, * &c. which ſerves as a baſis to the inſtructions requiſite to qualify Youth to appear with Dignity in the different Employments of Life, or to enable them in Time, to bring to perfection the various Arts for which they are intended.

PLAN of the Syſtem of the Phyſical and Moral World, including the Inſtructions relative to young Noblemen and Gentlemen of Fortune.

PLAN of the Syſtem of the Phyſical World.

——— Nubem pellente matheſi
Clauſtra patent cæli rerumque immobilis ordo,
Jam ſuperum penetrare domos atque ardua cæli
Scandere, ſublimis genii conceſſit acumen.

STUDY in General is neceſſary to Mankind, and eſſentially contributes to the Happineſs of thoſe who have experienced that active Curioſity which induceth them to penetrate the Wonders of Nature. It is, beſides, a preſervative againſt the Diſorders of the Paſſions, a kind of Study therefore which elevates the Mind, which applys it cloſely, conſequently, which furniſhes the moſt aſſured, arms againſt the Dangers we ſpeak, merits particular Diſtinction. "It is "not ſufficient, ſays *Seneca*, to know what we owe to our Country, "to our Family, to our Friends, and to our ſelves, if we have not "Strength of Mind to perform thoſe Duties, it is not ſufficient to "eſtabliſh Precepts, we muſt remove Impediments, *ut ad præcepta quæ* "*damus poſſit animus ire, ſolvendus eſt*, (epiſt. 95)." Nothing anſwers better this Purpoſe than the Application to the ſtudy of the Syſtem of the World; the Wonders which are diſcovered captivate the Mind, and occupy it in a noble Manner; they elevate the Imagination, improve the Underſtanding, and ſatiate the Heart: the greateſt Philoſophers of Antiquity have been of this Opinion. *Pythagoras* was accuſtomed to ſay, that Men ſhould have but two Studies, that of Nature, to enlighten their underſtandings, and of Virtue, to regulate their Hearts; in effect to become Virtuous, not through weakneſs but by Principle, we muſt be able to reflect and think cloſely; we muſt by dint of Study be delivered from Prejudices which make us err in our Judgments, and which are ſo many Impediments to the progreſs

* Quadratura curvarum, harmonia menſurarum, &c.

of our Reaſon, and the Improvement of our Mind. *Plato* held the Study of Nature in the higheſt Eſteem; he even goes ſo far as to ſay, that Eyes were given to Man to contemplate the Heavens.

Finxit in effigiem moderantum cuncta deorum,
Pronaque cum ſpectant animalia cetera terram,
Os homoni ſublime dedit cœlumque tueri,
Juſſit, et erectos ad ſidera tollere vultus.

The Poets who have illuſtrated *Greece* and *Italy*, and whoſe Works are now ſure of Immortality, were perfectly acquainted with the Heavens, and this Knowledge has been the ſource of many Beauties in their Works: *Homer*, *Heſiod*, *Aratus*, among the *Greeks*: *Horace*, *Virgil*, *Ovid*, *Lucretius*, *Manilius*, *Lucan*, *Claudian*, among the *Latins*: make uſe of it in ſeveral Places, and have expreſſed a ſingular Admiration for this Science.

Horace tells us, that he intends taking his Flight towards the Stars:

——— *Juvat ire per alta*
Aſtra, juvat terris et inani ſede relictis
Nube vehi, validique humeris inſiſtere atlantis.

Virgil ſeems deſirous of renouncing all other Study, to comtemplate the Wonders of Nature.

Me vero primum dulces ante omnia muſæ,
Quarum ſacra fero ingenti percuſſus amore,
Accipiant, cœlique vias et ſydera monſtrent
Defectus ſolis varios, lunæque labores,
Unde tremor terris, qua vi maria alta tumeſcant
Objicibus ruptis, rurſuſque in ſeipſa reſidant.
Quid tantum oceano properent ſe tingere ſoles
Hyberni, vel quæ tardis mora noctibus obſtet
Fœlix qui potuit rerum cognoſcere cauſas.

Geor. II. 475.

La Fontaine imitates the regrets of *Virgil* in a maſterly Manner, where he ſays,

Quand pourront les neuf ſœurs loin des cours & des villes
M'occuper tout entier, & m' aprendre des cieux
Les divers mouvements inconnus a nos yeux
Les noms et les virtues de ces clarte's errantes.

Songe dun habitant du Mogal.

Voltaire,

Voltaire, the firſt Poet of our Age, has teſtified in many Parts of his Works, his Taſte for Aſtronomy, and his Eſteem for Aſtronomers, whom he has celebrated in the fineſt Poetry. What he ſays of *Newton* is worthy of Attention.

Conſidens du tres haut, ſubſtances eternelles,
Qui parez de vos feux, qui couvrez des vos ailes
Le trone ou votre maitre eſt aſſis parmis vous,
Parles! du grand Newton n'etiez vous pas jaloux.

The great Geniuſes of every Species have been ſurprized at the Indifference which Men ſhew for the Spectacle of Nature. *Taſſo* puts Reflections in the Mouth of *Renaod*, which Merit to be recited for the Inſtruction of thoſe to whom the ſame Reproach may be applied; it is at the Time when marching before Day towards *Mount Olivet*, he Contemplates the Beauty of the Firmament.

Con gli occhi alzati contemplando intorno,
Qinci notturne e quindi matutine,
Bellezze incorruptibili e divine
Fra' ſe' ſteſſo penſava, o' quante belle
Duci, il tempio celeſte in ſe raguna!
Ha il ſuo gran carro il di, laurata ſtelle
Spiega la notte, e l argentata luna;
Ma non e' chi vagheggi o' queſta o' quelle;
E miriam noi torbida luce e bruna,
Ch'un girar d'occhi un balenar di riſo
Scopre in breve confin di fragil viſo!

Jerus. Cant. xviii. St. 12, 31.

ADVANTAGES reſulting from the Knowledge of the Syſtem of the World.

Is it not an Advantage to be freed from the Apprehenſions which Ignorance occaſions; can we recal without Compaſſion, the Stupidity of thoſe People, who believed that by making a great Noiſe when the Moon was eclipſed, this Goddeſs received relief from her ſufferances, or that Eclipſes were produced by Inchantments.

Cum fruſtra reſonant Era auxiliaria Lunæ. Met. iv. 333.
Cantus et e Curru Lunam deducere tentat,
Et faceret ſi non Æra repulſa ſonent. Tib. 1. El. 8.

See Sen. Hipolit. 787. Book 26. Tacit. Ann. Plutarch in Pericles et Liber de defectu Oraculorum.

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The Knowledge of the Syſtem of the Word has diſipated the Errors of Aſtrology, by whoſe fooliſh Predictions Mankind had been ſo long abuſed. The Adventure of 1186 ſhould have covered with ſhame the Aſtrologers of *Europe*, they were all, Chriſtians, Jews, and Arabians, united to anounce, ſeven Years before, by letters publiſhed throughout *Europe*, a Conjunction of all the Planets, which would be attended with ſuch terrible Ravages, that a general Diſſolution of Nature was much to be dreaded, ſo that nothing leſs than the End of the World was expected; this Year notwithſtanding paſſed as others. But a hundred Lyes, each as well atteſted, would not be ſufficient to wain ignorant and credulous Men from the Prejudices of their Infancy. It was neceſſary that a Spirit of Philoſophy, and reſearch, ſhould ſpread itſelf among Mankind, open their Underſtandings, unveal the the Limits of Nature, and accuſtom them not to be terrified without Examination, and without Proof.

The Comets, as it is well known, were one of the great Objects of Terror which the Knowledge of the Syſtem of the World has in fine removed. It is not without Concern we find ſuch ſtrange Prejudices in the fineſt Poem of the laſt Age, whereby they are tranſmitted to the lateſt Poſterity.

Qual con le chiome ſanguinoſe horende,
Splender cometa ſuol per laria aduſta,
Che regni ea fieri morti adduce,
Ea purperei tiranni infauſta luce.

Jerus. Lib.

The Charms of Poetry are actually employed in a manner more Philoſophical and uſeful, witneſs the following fine Paſſage.

Cometes que l'on craint a legal du tonnerre,
Ceſſe'z depouvanter les peuples de la terre;
Dans une Ellipſe immenſe achevez votre cours,
Remontez deſcendez pre's de l'aſtre des jours;
Lance'z vos feux, volez, et revenant ſans ceſſe
Des mondes epuiſez ranime'z la vielleſſe.

Thus the profound Study of the Syſtem of the World has diſſipated abſurd Prejudices, and re-eſtabliſhed human Reaſon in its inalienable Rights.

To the Knowledge of the Syſtem of the World, are owing the Improvements in Coſmography, Geography, and Navigation, the Obſervation, of the height of the Pole taught Men that the Earth was round

round, the Eclipſes of the Moon taught how to determine the Longitudes of the different Countries of the World, or their mutual Diſtances from Eaſt to Weſt. The diſcovery of the Satelites of Jupiter has contributed more effectually to improve Geographical or Marine Charts, than ten thouſand Years Navigation; and when their Theory will be better known, the Method of Longitudes will be ſtill more exact and more eaſy. The extent of the Mediterranean was almoſt unknown in 1600, and to Day is as exactly determined, as that of *England* or *Ireland*. By it the new World was diſcovered. *Chriſtopher Columbus* had a more intimate Knowledge of the Sphere, than any Man of his Time, ſince it gave him that Certainty, and inſpired him with that Confidence with which he directed his Courſe towards the Weſt, certain to rejoin by the Eaſt the Continent of *Aſia*, or to find a new one, And nothing ſeems to be wiſhed for, to render Navigation more perfect and ſure, but a Method for finding with eaſe the Longitude at Sea, which is now obtained by the means of the Moon: and if the Navigators of this Kingdom were initiated in Aſtronomy, by able Teachers, as is practiſed in other Parts of *Europe*, their Eſteem would approach within twenty Miles of the Truth, whilſt in ordinary Voyages the Uncertainty amounts to more than three hundred Leagues, by which the Lives and Fortunes of thouſands are endangered. The Utility therefore of the Marine to thoſe Kingdoms, where Empire, Power, Commerce, even Peace and War, are decided at Sea, proves that of the Knowledge of the Syſtem of the World.

The actual State of the Laws, and of the Eccleſiaſtical Adminiſtration, is eſſentially connected with the Syſtem of the World; St. *Auguſtine* recommended the Study of it particularly for this Reaſon; St. *Hyppolite* applied himſelf to it, as alſo many Fathers of the Church, notwithſtanding our Calendar was in ſuch a State of Imperfection, that the *Jews* and *Turks* were aſtoniſhed at our Ignorance. *Nicholas* V, *Leon.* X *&c.* had formed a Deſign of re-eſtabliſhing Order in the Calendar, but there were at that Time no Philoſophers, whoſe Reputation merited ſufficient Confidence. *Gregory* the XIIIth governed at a Time when the Sciences began to be cultivated, and he alone had the Honour of this Reformation.

Agriculture borrowed formerly fromt he Motions of the Celeſtial Bodies, its Rules and its Indications; *Job*, *Heſiod*, *Varro*, *Eudoxus*, *Aratus*, *Ovid*, *Pliny*, *Columella*, *Manilius*, furniſh a thouſand Proofs of it. The *Pleyades*, *Arcturus*, *Orion*, *Syrius*, gave to *Greece* and *Egypt* the Signal of the different Works; the riſing of *Syrius* announced to

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the *Greeks* the Harveſt; to the *Egyptians* the overflowing of the *Nile*. The Calendar anſwers this Purpoſe actually.

Ancient Chronology deduces from the Knowledge and Calculation of Eclipſes, the moſt fixed Points which can be found, and in remote Times we find but Obſcurity. The *Chineſe* Chronology is entirely founded upon Eclipſes, and we would have no uncertainty in the ancient Hiſtory of Nations as to the Dates, if there were always Philoſophers. (See the Art of verifying Dates.)

It is from the Syſtem of the World we borrow the Diviſion of Time, and the Art of regulating Clocks and Watches; and it may be ſaid, that the Order and Multitude of our Affairs, our Duties, our Amuſements, our Taſte, for Exactneſs and Preciſian, our Habitudes have rendered this Meaſure of Time almoſt indiſpenſable, and has placed it in the Number of the Neceſſaries of Life; if inſtead of Clocks and Watches, Meridians and Solar Dials are traced, it is an Advantage that the Knowledge of the Syſtem of the World has procured us, Dialling being the Application of Spherical Trigonometry; a Projection of the Sphere upon a Plane, or a Section of a Cone, according to the Forms given to a Dial.

The Knowledge of the Changes of the Air, Winds, Rain, dry Weather, Motions of the Thermometer, Barometer, have certainly an eſſential and immediate Relation with the Health of the Human Body; the Knowledge of the Syſtem of the World will be of ſenſible Utility, when, by repeated Obſervations, the Phyſical Influences of the Sun and Moon upon the Atmoſphere, and the Revolutions which reſult will be diſcovered. *Galen* adviſes the Sick not to call to their aſſiſtance Phyſicians, who are not acquainted with the Motions of the Celeſtial Bodies, becauſe Remedies given at unſeaſonable Times are uſeleſs or hurtful, and the ableſt Phyſicians of our Days are convinced, that the Attractions which Elevate the Waters of the Ocean twice a Day, influence the State of the Atmoſphere, and that the Criſis and Paroxiſms of Diſorders correſpond with the Situation of the Moon in reſpect of the Equator, Siſigies, and Apſides. See *Mead*, *Hofman*, &c.

Thoſe Advantages which reſult from the Knowledge of the Syſtem of the World, has cauſed it to be cultivated and held in ſingular Eſteem by all the civilized People of the Earth. The ancient Kings of *Perſia*, and the Prieſts of *Egypt*, were always choſen amongſt the moſt Expert in this Science. The Kings of *Lacedemon* had always Philoſophers in their Council. *Alexander* was always accompanied by them in his Military Expeditions, and *Ariſtotle* gave him ſtrict Charge to do nothing without their Advice. It is well known how much

Ptolemeus

Ptolemeus the ſecond King of *Egypt*, encouraged this Science, in his Time flouriſhed *Hyparchus*, *Calimachus*, *Apollonius*, *Aratus*, *Bion*, *Theocrites*, *Conon*. *Julius Cæſar* was very Curious in making Experiments and Obſervations, as it appears by the Diſcourſe which *Lucan* makes him hold with *Achore'* Prieſt of *Egypt*, at the Feaſt of *Cleopatra*.

——— Media inter prelia ſemper
Stellarum cœlique plagis ſuperiſque vacavi,
Nec meus Eudoxi vincetur faſtibus annus. Pharſ.

The Emperor *Tiberius* applied himſelf to the Study of the Syſtem of the World, as *Suetonius* relates; the Emperor *Claudius* foreſaw there would be an Eclipſe the Day of his Anniverſary, and fearing it might Occaſion commotions at *Rome*, he ordered an Advertiſement to be publiſhed, in which he Explains the Circumſtances, and the Cauſes of this Phenomenon. It was cultivated Particularly by the Emperors *Adrian* and *Severus*, by *Charlemagne*, by *Leon* V, Emperor of *Conſtantinople*, by *Alphonſe* X, King of *Caſtile*, by *Frederick* II, Emperor of the * *Weſt*, by *Calife Almamon*, the Prince *Ulubeigh*, and many other Monarchs of *Aſia*.

Among the Heroes who alſo cultivated it, are reckoned *Mahomet* II, Conqueror of the *Greek* Empire; the Emperor *Charles* the Vth, and *Lewis* XIV. In fine, the Eſtabliſhments of different Philoſophical Societies in *England*, *Scotland*, *France*, *Italy*, *Germany*, *Poland*, *Sweden*, *Ruſſia*, &c. have given the Monarchs, Nobility, and Gentry of thoſe Countries, a Taſte for the more refined Pleaſures attending the Study of the Sciences, and particularly of the Syſtem of the World, an Example worthy to be imitated by thoſe of this Kingdom.

PUBLICK SCHOOLS eſtabliſhed in the different Parts of Europe, for inſtructing young Noblemen and Gentlemen of Fortune in what regards the Syſtem of the World.

BESIDES thoſe renowned Societies which have all contributed to the Progreſs of every Branch of Human Knowledge, and particularly of the Syſtem of the World, there has been eſtabliſhed in the different Parts of *Europe* Publick Schools, conducted by Men of ſuperior Talents and Abilities, who make it their Buſineſs to guide and inſtruct the young Nobility and Gentry in this Noble Science, and furniſh thoſe who Diſcover ſingular Diſpoſitions with every Means of Improvement.

An Illuſtrious *Engliſhman*, *Henry Saville*, founded in the Univerſity of *Oxford* two Schools, which have been of vaſt Utility to *Englaud*;

* He ordered the Works of Ptolemeus to be tranſlated into Latin and publickly to be taught at *Naples*.

the Maſters have been all Men eminent in this Science, *John Bainbridge* in 1619, *John Greaves* in 1643, *Seth Ward*, *Chriſtopher Wren*, *Edward Bernard*, 1673, *David Gregory* in 1691, *Briggs*, *Wallis*, *J. Caſwell* 1708, *Keill* in 1712, *Hornſby*, &c.

The Schools eſtabliſhed at *Cambridge*, among whoſe Maſters were *Barrow*, *Newton*, *Cotes*, *Wiſton*, *Smyth*, *Long*, all celebrated Aſtronomers.

The School of *Greſham* at *Biſhops-Gate* in *London*, which has Eſſentially contributed to the Progreſs of Aſtronomy; among the Maſters of this School were Doctor *Hook*, and other eminent Men.

The Royal Mathematical School at *Chriſt's-Hoſpital*, where *Hodgeſon*, *Robertſon*, &c. have bred up a great Number of expert Navigators and Aſtronomers.

The Schools of *Edinburgh*, *Glaſgow*, and *Aberdeen*, are known all over *Europe*; the Nobility, and Gentlemen of Fortune of *Scotland*, ſuperintending them, and taking every Method of encouraging both Maſters and Students to Aſſiduity and Attention, to go through their reſpective Taſks with Alacrity and Spirit; the Names of *Gregory*, *McLaurin*, *Stuart*, *Simpſon*, &c. the famous Maſters, will never be forgotten.

The Royal School of *France*, founded by *Francis* the Firſt, has eſſentially contributed to the Progreſs of the knowledge of the Syſtem of the World. *Orance*, *Fine'*, *Stadius*, *Morin*, *Gaſſendi*, *de la Hire*, *de Liſle*, who were ſucceſſively Maſters of it, have been celebrated Aſtronomers, *&c.*

Experiments and Obſervations are the Foundation of all real Knowledge, thoſe which ſerve as a Baſis to the Diſcoveries relative to the Syſtem of the World, are made and learned in Experimental Schools and Obſervatories: The firſt Obſervatory of any celebrity, was Built by *William* V, Landgrave of *Heſſe*, where he collected all the Inſtruments, Machines, Models, *&c.* which were known in his Time, and put it under the direction of *Rothman* and *Byrgius*, the firſt an Aſtronomer, the ſecond an expert Inſtrument-Maker: The Duke of *Broglio*, General of the *French* Army, having rendered himſelf Maſter of *Caſſel* in 1760, took a Copy of the Obſervations and Experiments made in this Obſervatory, and depoſited them in the Library of the Academy.

Frederick the Iſt King of *Denmark*, being informed of the ſingular Merit of *Tycho Brahe*, granted him the Iſland of *Venuſia*, oppoſite *Copenhagen*, and built for him the Caſtle of *Uranibourgh*, furniſhed it with the largeſt, and the moſt perfect Inſtruments, and gave Penſions to a Number of Obſervers, Calculators, and Experiment Makers,

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to aſſiſt him, which enabled him in the Space of 16 Years, to lay the Foundation of the Syſtem of the World, in a Manner more ſtable, than was ever before effected. The moſt eminent Men took Pleaſure in viſiting this incomparable Philoſopher: The King of *Scotland* going to eſpouſe the Princeſs *Ann*, Siſter of the King of *Denmark*, paſſed into the Iſland of *Venuſia* with all his Court, and was ſo charmed at the Operations and Succeſs of *Tycho*, that he compoſed his Eulogium in *Latin* Poetry: So much Merit raiſed him Enemies, and the Death of King *Frederick* II, furniſhed them the Means of ſucceeding in their Machinations. A Miniſter called *Walchendorp* (whoſe Name ſhould be devoted to the Execration of the learned of all Ages) deprived him of his Iſland of *Venuſia*, and forbad him to continue at *Copenhagen* his Experiments and Obſervations.

The firſt Obſervatory of the laſt Age, was that of *Hevelius*, eſtabliſhed at *Dantzick*; it is deſcribed in his Great Work, intitled, *Machina Celeſtis*.

The Aſtronomical Tower of *Copenhagen* was finiſhed in 1656, Built by *Chriſtian* IV, at the Solicitation of *Longomontanus*.

There has been an Experimental School and Obſervatory at *Pekin* theſe 400 Years, Built on the Walls of the City: Father *Verbieſt* being made preſident of the Tribunal of Mathematicks in 1669, obtained of the Emperor *Cam-hy*, that all the *European* Inſtruments, Machines, Models, &c. ſhould be added to thoſe with which it was already furniſhed. (See the Deſcription of *China* by *Duhald*.) There has been made there a vaſt Collection of uſeful Experiments and Obſervations, a Copy of which is depoſited in the *French* Academy.

The Royal Obſervatory of *England* was built by *Charlee* II. under the direction of Sir *J. Moore*, four Miles from *London*, to the Eaſtward upon a high Hill: It will be for ever famous by the immortal Labours of *Flamſtead*, *Halley*, and *Bradley*; *Flamſtead* was put in Poſſeſſion of this Obſervatory in 1676, where, during the Space of 33 Years, he made a prodigious Number of Obſervations contained in his Hiſtory of the Heavens: *Halley* ſucceeded him, and was without doubt the greateſt Aſtronomer *England* produced; at the Age of Twenty he went to the Iſland of *St. Helen* to form a Catalogue of the Southeren Stars, which he publiſhed in 1679; then he went to *Danzick* to confer with *Hevelius*, he traveled alſo through *Italy and France* for his improvement; in 1683 he publiſhed his Theory of the Variation of the Magnetic Needle; in 1698 he received the Command of a Veſſel to traverſe the Atlantic Ocean, and viſit the *Engliſh* Settlements, in Order to diſcover whether the Variation of the Magnetic Needle, found by Experiment, agreed with his Theory, and to attempt new Diſcove-

ries; he advanced as far as 52*d.* South Latitude, where the Ice impeded his further Progreſs; he viſited the Coaſt of *Braſil*, the *Canaries*, the Iſlands of *Cape Verde*, *Barbadoes*, &c. and found every where the Variations of the Compaſs conformable to his Theory; in 1701 he was commiſſioned to traverſe the *Engliſh* Channel, to obſerve the Tides, and to take a ſurvey of the Coaſts; in 1708 he viſited the Ports of *Trieſte* and *Boccari* in the Gulph of *Venice*, and repaired the firſt, accompanied by the chief Ingineer of the Emperor; he publiſhed in 1705 the Return of the Comets of which he was firſt Diſcoverer; and we have ſeen in 1759 the Accompliſhment of his firſt Prediction; he examined the different Methods for finding the Longitude at Sea, and proved that thoſe which depend on the Obſervations of the Moon were the only practicable ones, and as thoſe Methods required accurate Tables of this Planet which did not differ from Obſervation more than two Minutes, he ſet about rectifying them, having diſcovered that to obtain this Point it was ſufficient to determine, every Day during 18 Years, the Place of the Moon by Obſervation, and to know how much the Tables differed from it, the Errors every Period afterwards being the ſame, and returning in the ſame Order: It was in 1722 that this couragious Aſtronomer, in the 65*th* Year of his Age, undertook this immenſe Work, and after having compleated it, and publiſhed the Succeſs of his Labours for foretelling accurately the Moon's Place and deducing the Longitude at Sea; we loſt this great Man the 25*th* of *January* 1742. *Bradley* ſucceeded him, who inriched Aſtronomy with his Diſcoveries and accurate Obſervations. *

The Royal Obſervatory not being ſufficient for all thoſe who purſue the Study of natural Philoſophy, there has been formed ſeveral Obſervatories in *London* and the different Parts of *England*, for Example the Obſervatory of *Sherburn* near *Oxford*, where the Lord *Macleſfield* late Preſident of the Royal Society, *M. Hornsby*, &c. have made Experiments and Obſervations for many Years, &c.

The Experimental School and Obſervatory of *Edinburgh*, built by the Subſcription of the Nobility and Gentry of that Kingdom, has been rendered famous by *Mc. Laurin.* The Royal Accademy of Sciences deputed in 1737 the King's Aſtronomer, *Le Monier*, to obſerve there an Annulary Eclipſe of the Sun.

The Royal Obſervatory of *Paris*, the moſt ſumptuous Monument that ever was conſecrated to Aſtronomy, was built under the Direction of the great *Colbert*, immortal Protector of the Arts and Sciences. It is near 200 Feet in Front, 140 from North to South, and 100 in height, the Vaults are near eighty Feet deep; there are alſo ſeveral others in *Paris*, and in other Parts of *France*, as that

* He departed this life the 13*th* of *July*, in the 70*th* Year of his Age: *M. Marſkeline* his ſucceſſor continues his obſervations with the moſt active Zeal and happy diſpoſitions.

that of *M. Lemonier* at the *Capuchiens* of *St. Honore*, that of *M. Deliſle* at the Hotel *de Cluny*, that of *M. La Caille* at the College of *Maſarin*, that of the Palace of *Luxemburgh*, that of *M. de Fouchy* in *Rue des Poſtes*, and that of *M. Pingre* at *St. Genevieve*; the Obſervatory of *Marſeilles* which *P. Pezenas* has rendered famous, that of *Lyons* where *P. Beraud* made Experiments and Obſervations for a long Time, that of *Rowen* and *Toulouſe* from which *M. Bowin* and *M. Dulange*, *M. d' Auguier*, ſend Annually to the Accademy a great Number of uſeful and curious Experiments and Obſervations; that of *Strasbourgh* where *M. Brakenaffer* has made ſome.

The Senate of the Republic of *Nuremberg*, erected an Obſervatory in 1678, and put it under the Direction of *Geo. Chriſtopher Eimmart*. *Phil. Wurzelban* built another in 1692, deſcribed in his Book *Uranies Noricæ Baſis*. The Adminiſtrators of the Univerſity of *Leyden*, eſtabliſhed in 1690, an Experimental School and Obſervatory. *Frederick* I. King of *Pruſſia*, having founded in 1700, an Academy of Sciences at *Berlin*, built an Experimental School, with an Obſervatory. The preſent King of *Pruſſia*, added a ſuperb Edifice, where the Academy actually holds its Aſſemblies. The Inſtitution of *Bologn*, a famous Academy, eſtabliſhed in 1709, by the Count of *Marſigli*, with the Permiſſion of *Clement* XI. has a fine Experimental School and Obſervatory, which *Manfredi* and *Zanotti* have rendered famous. There are four Experimental Schools, with Obſervatories, at *Rome*; that of *Blanchini*, that of the Convent of *Ara Cœli*, that of the Convent of *Minerva*, and that of *Trinite du Mont*. There is alſo one at *Genoa*, founded by the Marquis of *Salvagi*; one at *Florence*, which *Ximenes* has rendered famous; one at *Milan*, erected in the College of *Brera*, in 1713. The Superiors of the Univerſity of *Altorf*, in the Territory of *Nuremberg*, erected an Experimental School, and an Obſervatory, and furniſhed it with all the neceſſary Implements. In 1714, the Landgrave of *Heſſe*, *Charles* I. Heir of the States and Talents of the celebrated Landgrave we have already ſpoke of, built a new Experimental School and Obſervatory, and put it under the Direction of *Zumback*. In 1722, the King of *Portugal*, *John* V. erected an Experimental School and Obſervatory, in his Palace at *Liſbon*; there is alſo one in the College of St. *Antony*. The Experimental School and Obſervatory at *Peterſbourg*, is one of the moſt magnificent in *Europe*, it is ſituated in the Middle of the ſuperb Edifice of the Imperial Academy of *Peterſbourg*, it is compoſed of three Flights of Halls, adapted, for making Experiments and Obſervations, and is 150 Feet high. In 1726, the Magiſtrates of the Republick of *Utrecht*, built an Experimental School, and an Obſervatory, in which

the famous *Muſchembroek* made his Experiments and Obſervations. In 1739, the King of *Sweden* erected one at *Upſal*, and put it under the Direction of *Wargentin*. In 1740, the Prince of *Heſſe Darmſtad*, erected another at *Gieſſen*, near *Marbourgh*. There are two Experimental Schools and Obſervatories, at *Vienna*, where *P. Hell*, and *P. Liganig*, diſtinguiſh themſelves actually. There is one at *Tyrnaw* in *Hungary*; one in *Poland*, at *Wilna*, &c. &c.

Such are the renowned Eſtabliſhments to which we are indebted for our Knowledge of the Syſtem of the World, and the improvements it recives every Day; but there are a great many Branches, which require ſuch long Operations, and ſo great a Space of Time, that Poſterity will always have new Obſervations and Diſcoveries to make. *Multum egerunt qui ante nos fuerunt, ſed non peregerunt, multum adhuc reſtat Operis multumque reſtabit; nec ulli nato poſt mille Sæcula præcludetur Occaſio aliquid adhuc adjiciendi.* Seneca.

Method of teaching the Diſcoveries relative to the Syſtem of the World, extracted from a Diſcourſe prounounced at the Opening of ſome Exerciſes on Aſtronomy and Geography.

THE Engagements we contracted two Years ago with the Publick, might have prepoſeſſed them againſt us; it is not eaſy to conceive how, in ſo ſhort a Time, Youth could become Aſtronomers and Geographers; this Prejudice obliges us to juſtify our Boldneſs; it will be ſufficient to unfold the Plan which was laid down for us to follow, perhaps it will ſeem leſs aſtoniſhing that we attempted making ſome Steps in ſo difficult a Carreer. After we had ſpent ſome Time in learning Elementary Mathematicks, we were initiated in the Miſteries of ſublime Geometry, and of the Infiniteſimal Calculation, from theſe Abſtract Truths, we were led to the Diſcovery of the Phenomena of Nature, we endeavoured to diſcern their Cauſes, and to meaſure their Effects; from thence we were conducted as far as the Heavens, theſe immenſe Globes which roll over our Heads with ſo much Majeſty, Variety, and Harmoney, let themſelves be approached; we learned how to obſerve their Motions, and we inveſtigated the Laws, which are the Springs that animate the Fabrick of the World: in Order to repoſe us after theſe Speculations, we were brought back again upon Earth, where free from all Spirit of Syſtem, and Re-ſearch of Cauſes, we contemplated with a tranquil Eye the Wonders of Nature in Detail; it preſented at firſt an immenſe Field, whoſe whole Extent the greateſt Genius could not compaſs; but perſwaded that the Branches of Knowledge the moſt Eſtimable, and the only, worthy of a true Citizen, are thoſe which contribute

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to the good of Society; we confined ourſelves particularly to what might contribute to the Perfection of uſeful Arts, ſuch as Agriculture and Commerce: But thoſe inexhauſtable Mines, that the Time ſcarce permited us to open, will be explored with more Succeſs, by thoſe who are deſtined to receive the ſame Leſſons as we.

Principal Phenomena of the Syſtem of the World.

The Explication of the Cæleſtial Phenomena ſhould be preceded by the Expoſition of our Planetary Syſtem; the Cæleſtial Bodies which compoſe this Syſtem are to be divided into principal and ſecondary Planets, and thoſe which have Satelites diſtinguiſhed from the reſt. The Principal Planets ſhould be divided into ſuperior and inferior Planets; which are the inferior Planets? what is their diſpoſition? and how this Diſpoſition was diſcovered? which are the ſuperior Planets? what is their Arrangement? and how it has been diſcovered? is to be ſhewn; that the Planets are Opaque Bodies, and how it has been perceived, that they are of a Spherical Figure, and how it has been attained; in Fine, that all the Bodies of our Planetary Syſtem are of the ſame Nature, the Sun excepted, whoſe ſubſtance is that of Fire, is next to be proved; then the Nature of the Curves, which the Planets deſcribe round the Sun are to be inveſtigated, the Direction of their Motion to be determined, and the Nature of the Comets is to be ſhewn to be the ſame as that of the Planets. The Inveſtigation of the Laws of the Motion of the Planets and Comets ſhould follow, where the Relation which ſubſiſts between the Areas deſcribed and Times employed to deſcribe them; the Relation of the Periodic Times and the diſtances, the Proofs thoſe Laws furniſh in Favour of the Motion of the Earth, the Objections to it, the Anſwer to thoſe Objections, and the Diſcoveries which confirm them, are to be unfolded. From thence we ſhould paſs to the Reſearche of the Inclination of the Planes of the Planets to each other, and to the Plane of the Ecliptic, that of their Excentricities, and of their Diſtances to the Sun: the Motion of Rotation of the Planets preſents itſelf next, where the Means employed to diſcover it, in what Planets this Rotation is perceived, the Times of their Rotation round their Axis, the Effects of this Motion of Rotation in the Planets, in raiſing their Equators and depreſſing them towards the Poles, and in what Planets this Elevation of the Equator is ſenſible, are fully to be explained; the Demenſions of the Planets ſhould be afterwards inveſtigated, their Maſſes, their Denſities, the weight of the ſame Body at their Surfaces, the Proportions of the Bulk and of the Maſ-

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ſes of the Planets in reſpect of the Earth, and in reſpect of each other; thoſe Reſearches relative to the Principal Planets ſhould be terminated by an Enquiry into the Preceſſion of the Equinoxes, in what Direction this Motion is performed, in what Time it is accompliſhed, its Annual Quantity and the Neceſſity of making a Diſtinction between the Tropical and Sideral Year: from thence we ſhould proceed to the ſecondary Planets, the Laws of their Motions ſhould be ſhewn to be ſimilar to thoſe of the Planets, the Diſtances of the Moons, of Jupiter, and Saturn, to their Planets and their Periodic Times, are to be determined: Saturn's Ring next occurs, that it does not adhere to the Body of the Planet ſhould be proved, and its Diſtance to the Body of the Planet, its Diameter, its Breadth, its Thickneſs, are to be determined: the Motion of the Moon ſhould at length be diſcloſed, the Curve it deſcribes round the Earth, its Periodic and Sinodic Months, its Phaſes, its Figure, the Inclination of the Plane of its Orbit to that of the Ecliptic, the Motion and Time of Revolution of the Line of its Abſides and of its Nodes, its Excentricity, its Motion of Rotation, and in what Time it is performed, its Libration, and the Cauſe of it, its Diſtance to the Earth, Diameter, its Maſs, its Denſity, and what Bodies weigh at its Surface, are accurately to be inveſtigated.

THEORY of the PRINCIPAL PLANETS.

THIS Reſearch ſhould be preceded by an Explication of the Manner the ancient Philoſophers and *Decartes* accounted for the Circulation of the Planets in their Orbits; then it ſhould be proved that it is a centripetal Force which hinders the Planets from eſcaping by the Tangent, and that a projectile Force hinders them from falling to the Center; afterwards it ſhould be ſhewn how *Newton* diſcovered that the Force which makes the Planets tend to the Sun follows the inverſe duplicate Ratio of the Diſtances, from the Proportion which ſubſiſts between their Diſtances to the Sun and their periodic Times, ſuppoſing their Orbits to be circular, and that the periodic Times are in the ſame Proportion in Eliſes as in Circles, conſequently that the centripetal Force which retains the Planets in their Orbs, decreaſes as the Square of the Diſtances; that the centripetal Force being in this Proportion, the Planets can deſcribe but Conic Sections, in one of whoſe Focus the Sun reſides, how to determine the Orbit of a Planet, the Law of the centripetal Force being given, and what Curves other Laws of centripetal Forces would cauſe to be deſcribed; that it is the Proportion between the centripetal Force and projectile Force which is the Cauſe of the perpetual Circulation of the

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Planets in their Orbits, how the Planets can preſerve their Motion notwithſtanding the Reſiſtance of the Medium in which they move, that the Compariſon of the periodic Times and Diſtances of the Satellites of *Jupiter* and *Saturn* prove, that the Force which makes thoſe Satellites tend towards their principal Planets, follows the inverſe Duplicate Ratio of the Diſtances, how *Newton* diſcovered that the attractive Force of the Earth follows the ſame Proportion, and that the Meaſure of the Diameter of the Earth was neceſſary for this Diſcovery; from what Arguments he concluded the mutual Gravitation of all the Celeſtial Bodies; what is the Cauſe that makes one Body revolve round another, inſtead of forcing it to revolve round itſelf; whether it be the Maſs of the central Body, and how *Newton* attained to the Diſcovery of the Maſſes of the different Planets, by finding the Weights of the ſame Body upon the different Planets, at the ſame Diſtance from their Center, and how he deduced from thence their Denſities; that the denſeſt and ſmalleſt Planets are neareſt the Sun; and for what Reaſon; as alſo, why the Sun ſhould be the Center of the Celeſtial Revolutions; that the Alterations which the Planets naturally produce in their Courſes, follow the Ratio of their Maſſes; that Attraction is proportional to the Maſſes, without any Reſpect being had to the Form or to the Species of the Bodies which attract each other; that it is always reciprocal; that it acts uniformly and continually, and produces equal Accelerations in equal Times, whether the Body upon which it acts, moves, or is at Reſt; that the Effects of the Planets on the Sun conſiſt in making it oſcillate round the common Center of Gravity of our planetary Syſtem; that this Center of Gravity is at Reſt, conſequently cannot be the Center of the Sun which moves perpetually. That it inheres in each Particle of Matter. Why it is not ſenſible here below, but in very rare Caſes, as in the Deviation of the Plumb-Line at the Foot of Chimboroca; that the Attractions of the Load Stone, and of Electricity, have different Cauſes, and do not follow the ſame Laws as the univerſal Attraction of Bodies; that the Aphelia are ſenſibly at Reſt, which is a new Proof that Attraction acts in the duplicate Ratio of the Diſtance.

THEORY of the Figure of the EARTH.

HERE it ſhould be ſhewn, that the Motion of Rotation of the Planets, does not ſeem to depend on Gravity, and its Cauſe is entirely unknown, but that the mutual Gravity of the Parts which compoſe the Planets, hinders them from being diſſipated by their Rotation, which tends to change their Form. Then the Method that *Newton* deduced from his Principle of the mutual Gravity of the

Parts of Matter, to find the Proportion of the Axes of the Earth, ſhould be diſcloſed; but it ſhould be ſhewn, that the Depreſſion of the Earth towards the Poles, would always reſult from the Theory of centrifugal Forces, and of that of Fluids, whatever Hipotheſis of Gravity is aſſumed; that the Meaſures of the Degrees of the Meridian, taken at the polar Circle, and at the Equator, confirm theſe Determinations. Then the two Suppoſitions made in this Determination, *viz.* the Elipticity of the Meridians, and the Homogeniety of Matter, ſhould be examined; and it ſhould be proved that the firſt alone is legitimate. The latter may very poſſibly be falſe, and that the Ratio of the Axes of the Earth does not augment as Gravity increaſes towards the Poles, as *Newton* has thought; and the Cauſe of his Error is to be aſſigned. From thence we ſhould proceed to ſhew, how the Weights of Bodies in the different Regions of the Earth are determined; that they are proportional to the Lengths of Synchronal Pendulums; that the Degrees of Latitude are in the ſame Proportion; that the Experiments made in the different Regions of the Earth, confirm nearly thoſe Determinations: In fine, *Newton*'s Method for finding the Ratio of the Axes of any Planet, is to be unfolded, and applied for finding the Ratio of the Axes of *Jupiter*, and of the Sun; and the Reaſon given, why the Ratio of the Axes of the other Celeſtial Bodies, cannot be found.

THEORY of the Preceſſion of the EQUINOXES.

IT was thought for a long Time that the Axis of the Earth always preſerved its Parralleliſm. *Hiparchus* was the firſt who perceived the Revolution of the Poles of the Earth; *Ptolemy* fixed the Duration of this Revolution, and *Ulubeigh* the *Arabian*, corrected it; which Correction the preſent Aſtronomers have adopted. How this Revolution cauſes an apparent Motion in the fixed Stars, and cauſes the Interſection of the Equator and Ecliptic to move, and the Conſtellations of the Zodiac to change their Place, is to be ſhewn. Then it ſhould be explained, how *Newton*, by conſidering the Protuberance of the Earth, at the Equator, as a Ring of Moons adhering to the Globe of the Earth, deduces the Manner that the Attraction of the Sun upon the Elevation of the Earth, at the Equator, cauſes the Preceſſion of the Equinoxes. The Quantity that the Action of the Sun contributes to the Regreſſion of the Equinoctial Points, ſhould be aſſigned. And it ſhould be ſhewn, that it cauſes the annual Nutation of the Axis of the Earth, as the Moon cauſes a monthly Nutation; and that if the Earth was elevated towards the Poles, inſtead of towards the Equator, the Equinoctical Points

Points would advance inſtead of receding, which proves the Depreſſion of the Earth towards the Poles. That the Moon contributes to the Motion of the Equinoctial Points; and it ſhould be proved, that its Action on the Elevation of the Earth, towards the Equator, is more powerful than that of the Sun, and its Proportion is to be aſſigned, what is the total Quantity which the Action of the Sun and Moon makes the Equinoctial Points recede ſhould be determined; and it ſhould be proved, that this Quantity agrees with what has been found by Obſervation. In fine, that the Angle which the Axis of the Earth makes with the Ecliptic, diminiſhes continually; and what Elements enter into the Cauſe of this Diminution, are clearly to be ſtated.

THEORY of the Ebbing and Flowing of the SEA.

THE Errors of *Gallileo* concerning the Cauſe of the Tides being refuted, it ſhould be ſhewn, that they proceed from the Action of the Sun and Moon upon the Waters; then the Road that *Newton* purſued, and which led him to the Determination of the Quantity that each of thoſe Bodies contributes to produce thoſe Phenomena, and to the Proportion by which they are determined, ſhould be opened. As alſo the Method of eſtimating the Action of the Sun upon the Waters of the Sea, in any Place, and the preciſe Quantity of the Elevation of the Waters; how *Newton* attained to the determination of the Action of the Moon on the Sea; the Ratio of this Action to that of the Sun, and the Quantity of Elevation produced by thoſe two Forces united; why the Attraction of the Moon has ſuch Influence on the Waters of the Sea, and deranges ſo little the Motion of the Earth; then the different Kinds of Variations that occur in the Motion of the Sea, are to be enumerated; the diurnal Variations which conſiſt in its Ebbing and Flowing twice a Day; that the greateſt Elevation of the Water does not happen at the Moon's Appulſe to the Meridian, and why. The Menſtrual Variations, that the Tides are the greateſt twice each Month, at the new and full Moon, and the leaſt at the Quadratures, but do not anſwer preciſely at that Time, on Account of the vis Inertiæ of the Waters, that they are the greateſt, *ceteris paribus*, when the Moon is in its perigee, than when it is in its apogee; the annual Variations, the Tides are greater in Winter than in Summer, on account of the greater Proximity of the Sun; they depend alſo on the Declination of the Sun and of the Moon; that the Times and the Height of the Tides depend on the Latitude of the Places; that their Height diminiſhes in the duplicate Ratio of the ſine Compliment of Latitude; that the Greatneſs of the Tides depends of the Extent of the Seas; that the Tides of the *Mediterranean*

and *Adriatic* are ſcarce ſenſible; the Cauſes which influence the Tides, and that are inaſſignable; the Velocity of the Waters; that the Tides are always the greateſt towards the Coaſts, and why; then the different Phenomena which attend the Ebbing and Flowing of the Sea ſhould be unfolded; the Circumſtances which attend the Tides at *Batſham*, in the Kingdom of *Tunquin*, ſhould be explained. At the Entrance of Rivers the Ebbing laſts longer than the Flowing, and for what Reaſon; that at the Poles there is no diurnal Ebbing or Flowing, but only thoſe which depend on the Revolution of the Moon round the Earth; that in the frigid Zone there is one, and why there is not two, as in the other Regions of the Earth; why the Sun and Moon producing ſuch ſenſible Effects upon the Tides, produce no other ſenſible Effects here below. Conjectures concerning the Ebbing and Flowing of the Seas of *Jupiter* and its Satellites.

THEORY of the MOON.

IF the Lines drawn from the Moon and the Earth to the Sun, could be conſidered as parallel, the Sun would act with equal Force on them, conſequently would not diſturb the Motion of the Moon round the Earth; from the Angle therefore that thoſe Lines form, ſhould be deduced the Inequality of the Action of the Sun on the Earth and Moon. The Force of the Sun being reſolved into two others, the one urging the Moon towards the Earth, the other acting in the Direction of the Line drawn from the Earth to the Sun. The diſturbing Forces of the Sun ſhould be determined, and its Effects. How *Newton* determined the Accelleration which the Areas deſcribed receive from the diſturbing Force, which acts in a Direction parrallel to the Radius drawn from the Earth to the Sun. How he determined the Quantity that the diſturbing Force renders the Line which paſſes through the Quadrature, longer than that which paſſes through the Siſigies. In fine, how he deduced from the Combination of thoſe two Cauſes the Equation of the Motion of the Moon, which is ſtiled the Variation, conformable to Obſervation. From thence we ſhould paſs to the Conſideration of the Motion of the Nodes; firſt determining which of the two diſturbing Forces of the Sun ſhould be employed in this Reſearch. And what are the Laws of the Motion of the Nodes which reſult, the Conſequences which enſue, *viz.* the Regreſſion and Progreſſion of the Nodes in each Revolution, and the Formula of the Moons horary Motion in any Situation whatſoever, that is deduced. Then it ſhould be ſhewn, how *Newton* found the horary Motion of the Nodes, which is a Mean between all the different Motions which the For-

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mula gives; how he concluded the mean Place of the Nodes, and from thence the true Place for any giv Time, conformable to Obſervation. From the Reſearch of the Motion of the Nodes, we ſhould paſs to the Determination of the Changes which the Inclination of the Orbit of the Moon undergoes; and ſhew how *Newton* attained to the Determination of the horary Variation of this Inclination; and what Method he purſued to determine the Inclination of the Orbit for any given Time, conformable to Obſervation; from thence we ſhould proceed to the Determination of the Laws of the Motion of the Apogee; of the Variation of the Excentricity, and the other Inequalities of the Moon's Motion. The annual Equations of the Motion of the Moon, of the Apogee, and of the Nodes, are to be inveſtigated; ſhewing firſt that the mean Motion of the Moon ſhould be corrected by an Equation depending on the Diſtance of the Sun from the Earth; which is the greateſt when the Sun is perigee, leaſt in its Apogee. Secondly, that the mean Places of the Apogee, and of the Nodes, ſhould be corrected, each by an Equation of the ſame Kind, depending on the Diſtance of the Sun from the Earth, and Proportional to the Equation of the Center of the Sun; then the Semeſtrial Equations of the mean Motion of the Moon ſhould be unfolded; where it ſhould be made to appear, that the mean Motion of the Moon ſhould be again twice corrected. 1ſt, By an Equation depending at once on the Diſtance of the Sun from the Earth, and of the Situation of the Apogee of the Moon, in reſpect of the Sun. 2d, By an Equation depending on the Situation of the Sun in reſpect of the Nodes; as alſo, of the Diſtance of the Sun from the Earth. After thoſe three firſt Corrections of the Place of the Moon, follows that which is called the Equation of the Center of the Moon; but as its Excentricity varies at every Inſtant, and the Motion of the Apogee is very irregular, in order to attain to this Equation, the Excentricity and the true Place of the Apogee is firſt to be determined; which laſt, deduced from the Moon's Place, corrected by the three precedent Equations, gives the mean Anomaly of the Moon. With which Anomaly, and the Excentricity, the true Equation of the Center is obtained, and conſequently the Moons Place corrected for the fourth Time. The Place of the Moon corrected for the fifth Time, is found by applying to the Place of the Moon corrected for the fourth Time, the Equation called the Variation already inveſtigated, and the true Place of the Moon is in fine determined, by applying two other Equations, whoſe Foundation is accurately to be unfolded.

THEORY

THEORY of the COMETS.

THE Doctrine of the Peripateticks, who tranſmitting from Age to Age the Errors of their Maſter, maintaining that the Comets were Meteors, being refuted by the Obſervations of *Tycho*, which proves them to be ſituated beyond the Orbit of the Moon; as alſo the Opinion of *Decartes*, who neither thought of employing the Obſervations which were ſo eaſy for him to collect, nor Geometry, to which it was ſo natural to have Recourſe, but content to conſider them as Planets wandering from Vortex to Vortex: It ſhould be ſhewn how *Newton* found out that the Comets move round the Sun, and are ſubjected to the ſame Laws as the Planets; and how Calculation and Obſervation, the faithful Guides of this great Man, helped him to verify his conjectures, by clearly unfolding the Proceſs of his Solution of this fine Aſtronomico Geometrical Problem. Three Places of a Comet, which is ſuppoſed to move in a parabolic Orb, deſcribing round the Sun Areas proportional to the Times, being given, with the Places of the Earth correſponding to the ſame Times, to find the Poſition of the Axis, the Summit and Parameter of the Parabola, or which comes to the ſame; to find the Orbit of a Comet, and how he applied it to all the Comets obſerved, and that all the Places determined by Calculation from three Longitudes and Latitudes of the Comet, exactly coincided with the Places immediately deduced from Obſervation; then the Duration of the Periods of the Comets ſhould be deduced, from the Hiſtory of their Apparitions, in the ſame Circumſtances, and at equal Intervals, particularly thoſe which appeared in 1680, and 1682. The Examination of the Tails of the Comets ſhould follow, where the various Opinions concerning them, being diſcuſſed, it ſhould be proved, that they are Vapours which exhale from the Body of the Comet; then the Uſe of thoſe Tails ſhould be indicated. In fine, the Alterations which the Comets undergo at the Extremity of their Orbits, ſhould be remarked, that ſome of them fall into the Sun; and that the conſiderable changes which are obſerved in the fixed Stars, may proceed from thence.

CONCLUSION.

SUCH is the Plan of the immortal Diſcoveries of the moſt eminent Aſtronomers, and of Sir *Iſaac Newton* in particular, whoſe Efforts and Sagacity we cannot ſufficiently admire, which ſhine through the whole of thoſe Strokes of Genius, which characteriſe an Inventor, and of a Mind fertile in Reſources, that no Man poſſeſſed in ſo eminent a Degree. Aided by the Succours that the Analitick Art furniſhes

furniſhes in greater Abundance, it is not ſurprizing that ſome more Steps have been made in a vaſt and difficult Career that he has opened to us, that all the Irregularities that have been perceived in the Heavens, have been explained and demonſtrated; that a great Number of others, which on account of their Smallneſs and Complication have eſcaped the moſt exact Obſervers, have been foreſeen and unfolded; that it has been proved, that the Return of the Comet which was obſerved in 1531, 1607, and 1682, ought to have had the unequal Periods of $913\frac{1}{2}$ and $898\frac{1}{2}$ Months, which was found to be ſo, and that the Period after which it would appear again in this Age, would be 919 Months; which the Event has juſtified. That the Courſe and Laws of the Winds, the Ebbing and Flowing of the Sea, as far as they depend on the attractive Action of the Sun and Moon, have been accurately determined. That the Nature and Laws of Magnetiſm, the Theory of Light and Laws of Viſion, the Theory of Sound and Laws of Harmony, &c. have been accurately inveſtigated.

ANALITIC Exerciſes on the Syſtem of the World.

I. EXERCISE. Analitic Solutions of the Problems relative to the principal Planets.

II. EXERCISE. Analitic Inveſtigations of the Effects of the mutual Gravation of the principal Planets, where the Laws of all the inequalaties of their Motions ariſing from thence, are unfolded.

III. EXERCISE. Theory of all the irregularities of the Moons motion of the Satelites of Jupiter, and of thoſe of Saturn.

IV. EXERCISE. Upon the periodic Motion of Comets, and the irregularities in their Revolutions: occaſioned by the Action of the Planets.

V. EXERCISE. Upon the diurnal Revolution of the Planets, their Figures that reſult from thence, particularly of that of the Earth, and the Operations made in *Lapland* and *Peru* for this purpoſe; the Effects that enſue, *viz.* the Preceſſion of the Equinoxes.

VI. EXERCISE. Upon the Courſe and Laws of the Winds, the ebbing and flowing of the Sea, as far as they depend upon the atractive Action of the Sun and Moon.

VII. EXERCISE. Upon the Nature and Laws of Magnetiſm.

VIII. EXERCISE. Upon the Theory of Light and Laws of Viſion.

IX. EXERCISE. Upon the Theory of Sound and Laws of Harmony.

PLAN

PLAN of the Syſtem of the Moral World.

——— *Servare modum, finemque tueri,*
Naturamque ſequi, patriæque impendere vitam,
Non ſibi ſed toti genitum ſe credere mundo.

Lucan.

MEN in the State of Nature being apt to allow no other Rule for determining the differences which might ariſe among them but what is common to the brute Creation, namely, ſuperior Strength. The Eſtabliſhment of civil Society ſhould be conſidered as a Compact againſt Injuſtice and Violence, a Compact intended to form a Kind of Ballance between the different Parts of Mankind; but the moral Equilibrium, like the phiſical one, is rarely perfect and durable. Intereſt, Neceſſity, and Pleaſure, brought Men together, but the ſame Motives induce them continually to uſe their Endeavours to enjoy the Advantages of Society, without bearing the Charges neceſſary to its Support: and in this Senſe Men, as ſoon as they enter into Society, may be ſaid to be in a State of War; Laws are the ties, more or leſs Efficacious, intended to ſuſpend their Hoſtilities, but the prodigious Extent of the Globe, the difference in the Nature of the Regions of the Earth and its Inhabitants, not allowing Mankind to live under one and the ſame Government, it was natural that Men ſhould divide themſelves into a certain Number of States, diſtinguiſhed by the different Syſtems of Laws which they are bound to obey. Had all Mankind united under one Government, they would have formed a languid Body, extended without Vigor on the ſurface of the Earth. The different States are ſo many ſtrong and active Bodies, which lending each other mutual Aſſiſtance, form but one, and whoſe reciprocal Action ſupports the Life and Motion of the Whole.

The different Forms of Government in the WORLD.

All the States with which we are acquainted, partake of three Forms of Government, *viz.* the Republican, Monarchical, and Deſpotic. In ſome Places Monarchy inclines to Deſpotiſm, in others the Monarchical is combined with the Republican, &c. thoſe three Species of Government are ſo entirely diſtinct, that properly ſpeaking, they have nothing in common: We ſhould therefore form of thoſe three, ſo many diſtinct Claſſes, and endeavour to inveſtigate the Laws peculiar to each; it will be eaſy afterwards to modify thoſe Laws in their

their Application to any Government whatſoever, in proportion as they relate more or leſs to thoſe different Forms. In the different States the Laws ſhould be conformable to their Nature, that is to what conſtitutes them, and to their Principle, or to that which ſupports and gives them Vigour. The Laws relative to the Nature of Democracy ſhould be firſt explained; it ſhould be ſhewn how the People in ſome reſpects are Monarchs, and in other Subjects; how they elect and judge their Magiſtrates, and how their Magiſtrates decide in certain Caſes, *&c.* then the Laws relative to the Nature of Monarchies ſhould be unfolded; the Degrees of delegated Power and intermediate Ranks that intervene between the Monarch and the Subject, the Duties of the Body to be appointed, the Guardian of the Laws to mediate between the Prince and the Subject ſhould be properly ſettled: In fine, it ſhould be proved, that the Nature of Deſpotiſm requires, that the Tyrant ſhould exert his Authority, either in his own Perſon, or by ſome other who repreſents him; afterwards the Principles of the three Forms of Governments ſhould be pointed out; it ſhould be proved, that the Principle of Democracy is the Love of Equality, whereby is meant, not an abſolute, rigorous, and conſequently chimerical Equality, but that happy Equilibrium which renders all its Members equally ſubject to the Laws, and equally intereſted in their Support: That in Monarchies, where a ſingle Perſon is the Diſpenſer of Diſtinctions and Rewards, the Principle is Honour, to wit Ambition, and the Love of Eſteem; and in Deſpotiſm, Fear. The more vigorouſly thoſe Principles operate, the greater the Stability of the Government; and the more they are relaxed and corrupted, the more it inclines to Deſtruction.

The Syſtems of Education, ſuitable to each Form of Government, ſhould follow: It ſhould be proved, that they ought to be conformable to the Principle of each Government: That in Monarchies, the principle Object of Education ſhould be the Art of pleaſing; as productive of Refinement of Taſte; Urbanity of Manners; an Addreſs that is natural, and yet engaging, whereby Civil Commerce is rendered eaſy and flowing. In deſpotic States, the principal Object ſhould be to inſpire Terror and implicit Obedience; in Republicks all the Powers of Education are required; every noble Sentiment ſhould be carefully inſtilled; Magnanimity, Equity, Temperance, Humanity, Fortitude, a noble Diſintereſtedneſs, from whence ariſes the Love of our Country.

The Laws relative to the Principle of each Government next occur; it ſhould be ſhewn, that in Republicks, their principle Object ſhould be to ſupport Equality and Œconomy; in Monarchies, to maintain the Dignity of the Nobility, without oppreſſing the People;

in Deſpotic Governments, to keep all Ranks quiet. Then the Differences which the Principles of the three Forms of Government ſhould produce in the Number and Object of the Laws, in the Form of Judgments and Nature of Puniſhments, ſhould be explained; it ſhould be proved, that the Conſtitution of Monarchies being invariable, in order that Juſtice may be rendered in a Manner more uniform and leſs arbitrary: More civil Laws and Tribunals are required, which are accurately to be deſcribed; that in temperate Governments, whether Monarchical or Republican, Criminal Laws cannot be attended with too many Formalities; that the Puniſhments ſhould not only be proportioned to the Crime, but as moderate as poſſible; that the Idea annexed to the Puniſhment, frequently will operate more powerfully than its Intenſity; that in Republicks, the Judgment ſhould be conformable to the Law, becauſe no Individual has a Right to alter it; in Monarchies, the Clemency of the Sovereign may abate its Rigour; but the Crimes ſhould be always judged by Magiſtrates appointed to take Cognizance of them. In fine, that it is principally in Democracies, that the Laws ſhould be ſevere againſt Luxury, Diſſoluteneſs of Manners, and the Seduction of the Sex.

The Advantages peculiar to each Government, ſhould in fine be enumerated; it ſhould be proved, that the Republican is better ſuited to ſmall States, the Monarchical to great Empires; that Republicks are more ſubject to Exceſſes, Monarchies to Abuſes; that in Republicks the Laws are executed with more Deliberation, in Monarchies with more Expedition. As to deſpotic Governments, to point out the Means neceſſary for its Support, is in effect to ſap its Foundation; the Perfection of this Government is its Ruin; and the exact Syſtem of Deſpotiſm is at once the ſevereſt Satire, and the moſt formidable Scourge of Tyrants.

Particulars in which all Forms of Government agree.

The general Law of all Governments, at leaſt temperate ones, and conſequently juſt, is political Liberty; the full Enjoyment of which ſhould be ſecured to each Individual: This Liberty is not the abſurd Licence of doing whatever one pleaſes, but the Privilege of doing whatever is permitted or authoriſed by Law; it may be conſidered either as it relates to the Conſtitution or to the Individual. It ſhould be ſhewn, that in the Conſtitution of every State, there are two Powers, the Legiſlative and Executive, and that this latter has two Objects, the Internal and External Policy; in the legal Diſtribution of thoſe different Sorts of Power, conſiſts the greateſt Perfection of Political

Political Liberty, with reſpect to the Conſtitution; in Proof of which ſhould be explained the Conſtitution of the Republick of *Rome*, and that of *Great Britain:* It ſhould be ſhewn, that the Principle of the latter is founded on the Fundamental Law of the ancient *Germans*; namely, that Affairs of ſmall Conſequence were determined by the Chiefs, and thoſe of Importance were referred to the general Aſſembly of the whole Nation, after being previouſly examined by the Chiefs. Political Liberty conſidered, with reſpect to Individuals, conſiſts in the Security which the Law affords them, whereby one Individual is not in dread of another. It ſhould be ſhewn, that it is principally by the Nature and Proportion of Puniſhments that this Liberty is eſtabliſhed or deſtroyed: That Crimes againſt Religion ſhould be puniſhed by the Privation of the Advantages which Religion procures; the Crimes againſt good Morals, by Infamy; Crimes againſt the publick Tranquility, by Priſon or Exile; Crimes againſt private Security, by corporal Puniſhments: That Writings are leſs criminal than Deeds; meer Thoughts are not puniſhable; Accuſation without a regular Proceſs, Spies, anonymous Letters; all thoſe Engines of Tyranny, equally infamous with reſpect to the Inſtruments and the Employers, ſhould be proſcribed in every good Government, that no Accuſation ſhould be urged but in the Face of the Law, which always puniſhes Guilt or Calumny: In every other Caſe, the Magiſtrate ſhould ſay, *we ſhould abſolve from Suſpicion, the Man who wants an Accuſer, without wanting an Enemy.* That it is an excellent Inſtitution to have publick Officers appointed, who in the Name of the State may proſecute Criminals: This will produce all the Advantages of Informers, without their Inconveniencies and Infamy.

The Nature and Manner of impoſing and collecting Taxes ſhould afterwards be explained: It ſhould be proved, that they ſhould be proportioned to Liberty; conſequently in Democracies they may be heavier than in other Governments, without being burthenſome; becauſe each Individual conſiders them as a Tribute he pays himſelf, and which ſecures the Tranquility and Fortune of each Member: Beſides, in Democracies, the Miſapplication of the public Revenues is more difficult, becauſe it is more eaſily diſcovered and puniſhed; each Individual having a Right to call the Treaſurer to an Account. That in every Form of Government, thoſe Taxes that are laid on Merchandizes are leaſt burthenſome, becauſe the Conſumer pays without perceiving it: That the exceſſive Number of Troops in Time of Peace, is only a Pretext to overcharge the People with Taxes; a Means of enervating the State, and an Inſtrument of Ser-

vitude. In fine, that the Collecting of the Duties and Taxes by Officers appointed for this Purpoſe, whereby the whole Product enters the publick Treaſury, is by far leſs burthenſome to the People, and of Conſequence more advantageous than the farming out of the ſame Duties and Taxes, which always leaves in the Hands of a few private Perſons, a Part of the Revenues of the State.

Particular Circumſtances which ſhould modify the different Forms of Government.

THE Circumſtances independent of the Nature of the Form of Government, which ſhould modify the Laws, ariſe principally from the Nature of the different Regions of the Earth, and the different Characters of the People which inhabit them. Thoſe ariſing from the Nature of the Regions of the Earth, are two-fold; ſome regard the Climate, others the Soil. Nobody doubts but the Climate has an Influence on the habitual Diſpoſition of Bodies, conſequently on the Characters, the Laws ſhould be therefore conformable to the Nature of the Climate in indifferent Matters, and on the contrary check it vicious Effects; an exact Enumeration of which is to be made, and the Laws for correcting them to be explained; it ſhould be ſhewn, how in Countries where the Heat of the Climate inclines the People to Indolence, the Laws encourage them to Labour; where the Uſe of Spiritous Liquors is prejudicial, they are diſcouraged, *&c.* The Uſe of Slaves being authoriſed in the hot Countries of *Aſia* and *America*, and prohibited in the temperate Climates of *Europe*, the Lawfulneſs of Civil Slavery ſhould next be enquired into; it ſhould be proved, that Men having no more power over the Liberty than over the Lives of one another, Slavery in general is inconſiſtent with the Law of Nature; that there has never been perhaps but one juſt Law in Favour of Slavery, *viz.* the *Roman* Law, whereby the Debtor was rendered the Slave of the Creditor; the Limitation of this Servitude, both as to the Degree and as to the Time, ſhould be pointed out. That Slavery at the utmoſt can be tolerated in deſpotic States, where free Men, too weak againſt the Government, ſeek for their own Advantage, to become the Slaves of thoſe who tyrannize over the State; or elſe in Climates where the Heat ſo enervates the Body and weakens the Spirits that Men can not be brought to undergo painful Duties only by the fear of Puniſhment.

From thence we ſhould paſs to the Conſideration of the domeſtic Servitude of Women in certain Climates: It ſhould be ſhewn, that it ſhould take Place in thoſe Countries where they are in a State of cohabiting

habiting with Men before they are able to make uſe of their Reaſon; marriagable by the Laws of the Climate, Infants by thoſe of Nature: That this Subjection is ſtill more neceſſary in thoſe Countries where Poligamy is eſtabliſhed, a Cuſtom in ſome Degree founded on the Nature of the Climate and the Ratio of the Number of Women to that of Men; then the Nature of Repudiation and Divorce ſhould be examined, and it ſhould be proved, that if once allowed, it ſhould be allowed in Favour of Women as well as of Men.

In fine, political Slavery ſhould be treated of; it ſhould be proved, that the Climate which has ſuch Influence in producing domeſtic and civil Servitude, has not leſs in reducing one People under the Obedience of another; that the Northern People having more Strength and Courage than thoſe of Southeren Climates, the former are deſtined to preſerve, the latter to looſe their Liberty; in Confirmation of which, the various Revolutions which *Europe*, *Aſia*, *&c.* have undergone, ſhould be unfolded; the Cauſes of the Riſe and Fall of Empires ſhould be pointed out, particularly thoſe of the *Roman* Empire; it ſhould be proved, that its Riſe was principally owing to the Love of Liberty, of Induſtry, and of Country, Principles inſtilled into the Minds of the People from their earlieſt Infancy; to thoſe inteſtine Diſſentions, which kept all their Powers in Action, and which ceaſed at the Approach of an Eenemy; to their intrepid Conſtancy under Misfortunes, which made them never diſpair of the Republick; to that Principle from which they never receded, of never concluding Peace untill they were victorious; to the Inſtitution of Triumphs, which animated their Generals with a noble Emulation; to the Protection they granted Rebels againſt their Sovereigns; to their wiſe Policy of leaving to the Vanquiſhed their Religion and their Cuſtoms; In fine, to their Maxim of never engaging in War with two powerful Enemies at once, ſubmitting to every Inſult from one, untill they had cruſhed the other; that its Fall was occaſioned by the too great Extent of the Empire, which changed the popular Tumults into Civil Wars; by their Wars abroad, which forcing the Citizens to too long an Abſence, made them looſe inſenſibly the Republican Spirit; by the Corruption which the Luxury of *Aſia* introduced; by the Proſcriptions of *Sylla*, which debaſed the Spirit of the Nation, and prepared it for Slavery; by the Neceſſity they were in of ſubmitting to a Maſter, when their Liberty became burthenſome to them; by the Neceſſity they were in of changing their Maxims, in changing their Form of Government; by that Succeſſion of Monſters, who reigned almoſt without Interruption, from *Tiberius* to *Nerva*, and from *Comodus* to *Conſtantine*; In fine, by the Tranſlation and Diviſion

of

of the Empire, which was deſtroyed, firſt in the *Weſt*, by the Power of the *Barbarians*; and after having languiſhed many Ages in the *Eaſt*, under weak or vicious Emperors, inſenſibly expired.

The Laws relative to the Nature of the Soil ſhould next be explained; it ſhould be ſhewn, that Democracies are better ſuited than Monarchies to barren and mountainous Countries, which require all the Induſtry of their Inhabitants; that a People who till the Soil, require more Laws than a Nation of Shepherds, and thoſe more than a People who live by Hunting; thoſe who know the Uſe of Coin, than thoſe who are ignorant of it.

The Laws relative to the Genius of the different People of the Earth at length ſhould be diſcloſed, and it ſhould be proved, that Vanity which magnifies Objects is a good Reſort of Government, Pride which depreſſes them is a dangerous one; that the Legiſlator in ſome Meaſure, ſhould reſpect Prejudices, Paſſions, and Abuſes; as the Laws ſhould not be the beſt, conſidered in themſelves, but with reſpect to the People for which they are made; for Example, a People of a gay Character requires eaſy Laws; thoſe of harſh Characters, more ſevere ones. The Manners and Cuſtoms are not to be changed by Laws, but by Recompences and Example: In fine, what the different Religions have, conformable or contrary to the Genius and Situation of the People who profeſs them, is to be explained.

The Relations of which the different Forms of Government are ſuſceptable.

THE different States conſidered with reſpect to each other, may yield mutual Aſſiſtance, or cauſe mutual Injury. The Aſſiſtance they afford is principally derived from Commerce, its Laws are therefore to be unfolded; it ſhould be proved, that though the Spirit of Commerce naturally produces a Spirit of Intereſt, oppoſed to the Sublimity of moral Virtues, yet it renders a People naturally juſt, and baniſhes Idleneſs and Rapine. That free Nations, who live under moderate Governments, ſhould apply themſelves to it more than thoſe who are enſlaved; that one Nation ſhould not exclude another from its Commerce without important Reaſons; that the Liberty however of Commerce does not conſiſt in allowing Merchants to act as they pleaſe; a Faculty which would be very often prejudicial to them, but in laying them under ſuch Reſtraints only, as are neceſſary to promote Trade; that in Monarchies the Nobility ſhould not purſue it, much leſs the Prince: In fine, that there are Nations to whom Commerce is diſadvantageous; it is not thoſe who want for nothing,

but

but thoſe who are in want of every thing; as *Poland*, by whoſe Commerce the Peaſants are deprived of their Subſiſtence, to ſatisfy the Luxury of their Lords: The Revolutions which Commerce has undergone, ſhould next be diſplayed, and the Cauſe of the Impoveriſhment of *Spain* by the Diſcovery of *America*, pointed out: In fine, Coin being the principal Inſtrument of Commerce, the Operations upon it ſhould be treated of, ſuch as Exchange, Payment of publick Debts, Intereſt, *&c.* whoſe Laws and Limits are to be ſettled.

Population and the Number of Inhabitants being immediately connected with Commerce, and Marriages having for their Object Population, every thing relative thereto ſhould be accurately explained; it ſhould be ſhewn, that publick Continence is that which promotes Propagation; that in Marriages, though the Conſent of Parents is with Reaſon required, yet it ſhould be ſubject to Reſtrictions, as the Law ſhould be as favourable as poſſible to Marriage; that the Marriage of Mothers with their Sons, on account of the great Diſparity of the Ages of the Contractors, could rarely have Propagation for Object, and conſidered even in this Light, ſhould be prohibited; that the Marriage of the Father with the Daughter might have Propagation for Object, as the Virtue of Engendering ceaſes a great deal later in Men, and has in Conſequence been authoriſed in ſome Countries; that as Nature of herſelf inclines to Marriage, the Form of Government muſt be defective, where it ſtands in Need of being encouraged; that Liberty, Security, moderate Taxes, the Proſcription of Luxury, are the true Principles and Support of Population; that Laws notwithſtanding may be made with Succeſs, for encouraging Marriages, when, in ſpight of Corruption, the People are attached to their Country; what Laws have been made to this Purpoſe, particularly thoſe of *Auguſtus*, are to be unfolded; that the Eſtabliſhment of Hoſpitals may either favour or hurt Population, according to the Views in which they have been planned; that there ſhould be Hoſpitals in a State where the greateſt Part of the Citizens have no other Reſource than their Induſtry; but that the Aſſiſtance which thoſe Hoſpitals give ſhould be temporary; unhappy the Country where the Multitude of Hoſpitals and Monaſteries, which are only perpetual Hoſpitals, ſets every body at their Eaſe, except thoſe who labour.

To prevent the mutual Injury which States may receive from each other, Defence and Attack are rendered neceſſary; it ſhould be ſhewn, that Republicks by their Nature being but ſmall States, cannot defend themſelves but by Alliances; but that it is with Republicks

publicks they ſhould be formed. That the defenſive Force of Monarchies conſiſts principally in having their Frontiers fortified. That States as well as Men, have a Right to attack each other for their own Preſervation, from whence is derived the Right of Conqueſt, the general Law of which is to do as little Hurt to the Vanquiſhed as poſſible. That Republicks can make leſs conſiderable Conqueſts than Monarchies; that immenſe Conqueſts introduce and eſtabliſh Deſpotiſm; That the great Principle of the Spirit of Conqueſt ſhould be to render the Condition of the conquered People better, which is fulfilling at once the natural Law and the Maxim of State, how far the *Spaniards* receded from this Principle, in exterminating the *Americans*, whereby their Conqueſt was reduced to a vaſt Deſert, and they were forced to depopulate their Country, and weaken themſelves for ever, even by their Victory, ſhould be explained. That it may beccme neceſſary to change the Laws of a vanquiſhed People, but never their Manners and Cuſtoms. That the moſt aſſured Means of preſerving a Conqueſt, is to put the Vanquiſhed and Victors on a level if poſſible, by granting them the ſame Rights and Privileges; how the *Romans* conducted themſelves in this Reſpect, ſhould be related; as alſo how *Cæſar* with reſpect to the *Gauls*.

The LAWS reſulting from the Nature, Circumſtances, and Relations, of the different Forms of Government.

AFTER having treated in particular of the different Species of Laws there remains no more to be done, but to compare them together, and to examine them, with reſpect to the Objects on which they are enacted. Men are governed by different Kinds of Laws, by the natural Law common to each Individual; by the divine Law, which is that of Religion; by the Eccleſiaſtical Law, which is that of the Policy of Religion; by the Civil Law, which is that of the Members of the ſame Community; by the Political Law, which is that of the Government of the Community; by the Law of Nations, which is that of Communities conſidered with reſpect to each other; each of thoſe have their diſtinct Objects, which are not to be confounded, nor what belongs to one be regulated by the other; it is neceſſary that the Principles which preſcribe the Laws, reign alſo in the Manner of compoſing them; the Spirit of Moderation ſhould as much as poſſible direct all the Diſpoſitions: In fine, the Stile of the Laws ſhould be ſimple and grave, it may diſpenſe with Motives, becauſe the Motive is ſuppoſed to exiſt in the Mind the Legiſlator; but when they are aſſigned, they ſhould be founded on evident Principles.

CON-

CONCLUSION.

Such is the Plan of the Syſtem of the Moral World, where the Inhabitants of this Earth are conſidered in their real State, and under all the Relations of which they are ſuſceptible; the Moral Philoſopher without dwelling on meer ſpeculative and abſtract Truths, in pointing out the Duties of Man, and the means of obliging him to diſcharge them, has leſs in view the Metaphiſical Perfection of the Laws, than what human Nature will admit of; the Laws that are exiſting, than thoſe which ſhould be eſtabliſhed; and as a Citizen of the World confined to no Nation or Climate; he makes the Laws of a particular People leſs the Object of his Reſearch, than thoſe of all the People of the Univerſe.

PLAN of the Military Art, including the Inſtructions relative to Engineers, Gentlemen of the Artillery, and in general to all Land-Officers.

Intenti expectant Signum, exultantiaque haurit
Corda pavor pulſans, Laudumque arrecta Cupido.

Since the Revolution which the Invention of Gunpowder has produced in *Europe*, but above all, ſince Philoſophy born to conſole Mankind, and to make them happy, has been forced to lend its Light to teach Nations how to deſtroy one another. The Art of War formes, a Science as vaſt as it is complicated, compoſed of the Aſſemblage of a great Number of Sciences united and connected together, lending each other mutual Aſſiſtance, and which the Youth of this Country who are intended for the Military State, can never acquire but in a Military School, eſtabliſhed by publick Authority, and conducted by a Man of ſuperior Talents and Abilities.

MATHEMATICKS.

There the young Officers ſhould be firſt brought acquainted with Algebra and Geometry, elementary, tranſcendental and ſublime, which will teach them the general Properties of Magnitude and Extention; how to calculate the Relations of their different Parts; how to apply them for determining acceſſible and inacceſſible Angles and Diſtances, tracing of Camps, ſurveying of Land, drawing of Charts, cubing the Works of Fortifications, *&c.* and will give them that Spirit of Combination, which is the Foundation of all Arts, where Imagination does not predominate, as neceſſary to the military Gentleman as to the Aſtronomer, which has formed *Turenne* and *Cohorn*, as *Archimedes* and *Newton*.

MECHANICKS and DYNAMICKS.

Theſe abſtract Notions will ſerve as an Introduction for attaining the Art which teacheth the Properties of Motion, to meaſure the Times and Spaces, to calculate the Velocities, and to determine the Laws of Gravity, to command the Elements by which we ſubſiſt, whoſe Forces it teaches to ſubdue, and learns how to employ all that is at our Reach in Nature, in the moſt advantageous manner, either to aſſiſt us in our Enterprizes, by ſupplying our Weakneſs, or to ſatisfy our Wants, and procure us all kind of Conveniencies.

MILITARY ARCHITECTURE.

They ſhould be taught the Application of this admirable Art, more particularly for regulating the Dimenſions which ſuit the Linings of the Works of Fortification, that they may reſiſt the Preſſure of the Earth, which they are to ſuſtain, by determining the Law according to which this Preſſure acts. For eſtimating the Reſiſtance that Counterforts are capable of, according to their Length, Thickneſs, and their Diſtances from one another, for calculating how the Efforts of Vaults act, in order to deduce general Rules for determining their Thickneſs, according to the Forms that are to be given them in the different Uſes that are made of them in Fortification, either for ſubterraneans, City Gates, Magazeens of Powder, *&c.* for aſſigning the Form of Bridges, relative to the ſpreading of the Arches, determining the Streſs and Strength of Timber, the Proportions of the Parts of Works, that they may have an equal relative Strength with reſpect to the Models, according to which they are executed in large Dimenſions.

BALLISTIC.

Then ſhould be unfolded the Theory of the Force and Action of Gunpowder, as it ſerves to regulate the Proportions of Cannons, Mortars, Guns, *&c.* that of Elaſtick Fluids, as it teacheth to determine the actual Degree of the Reſiſtance of the Air to Shells and Bullets, and to aſſign the real Tract deſcribed by thoſe Millitary Projectils.

PNEUMATICKS.

Then the Uſe that can be made of the Dilatation and Condenſation of the Air, as of the Force that its Springs acquires by Heat, to move Machines, ſhould be explained, by ſhewing the Effects of Pumps, deſcribing the Properties of all the Kinds that have hitherto been invented; pointing out their Defects and Advantages; to what Degree

gree of Perfection they can be brought; determining the moſt advantageous Proportions and Forms of their Parts, and of all the Machines contrived to make them move, either of thoſe intended for the Uſe of private Perſons, for extinguiſhing Fires, for ſupplying publick Fountains, *&c.* unfolding the Conſtruction of all thoſe that have been hitherto executed in the different Parts of *Europe*, which are put in Motion either by Animals, by the Courſe of Rivers, by the Force of Fire, explaining how this Agent, the moſt powerful in Nature, has been managed with the greateſt Art; afterwards it ſhould be ſhewn how to calculate the Force of the Wind, the Advantages that can be drawn from it, for draining an Aquatick or Maracageous Land, or to water a dry Ground; exemplified by what has been practiſed in the different Parts of *Europe* in this Way.

HYDRAULICKS.

The Art of conducting, raiſing, and managing Water, is next to be diſcloſed; it ſhould be ſhewn how to raiſe Water above the Level, of its Source by means of its Gravity without making uſe of the Parts which enter into the ordinary Compoſition of Machines; how to diſcover by Calculation, if a Water of a given Source, or raiſed to a given Height, by any Machine, can attain to a given Place, either by Trenches, Aqueducts, or Pipes; how to conſtruct Baſons, Water-Houſes, and Ciſterns to preſerve it; how to diſtribute it through the different Parts of a City, determining the moſt advantageous Dimenſions and Diſpoſitions of the Conduits, and deſcribing the moſt uſeful and ingenious hitherto executed.

As nothing is more agreeable to the Sight than Water-Works, the manner of laying them out, and the Conſtruction of the Machines imagined to raiſe the Water into the Reſervoirs, which are the Soul of all thoſe Operations, ſhould be unfolded, in order that the Engineer may be able to point out to thoſe who are willing to embelliſh their Gardens, what ſuits them as to the Expence they are willing to be at, or the Situation of the Place; and that the Officer may be able to judge of the Beauty of Objects of this kind.

Water being of all Agents that from which the greateſt Advantage can be drawn for animating Machines, it ſhould be ſhewn how to apply it to the Wheels of the different kinds of Mills; what Velocity they ſhould have relative to the Current which moves them, in order that the Machines may be capable of the greateſt Effect; entering into the Detail of all their different Species; calculating the Force neceſſary to put them in Motion; the Effect they are capable of, by Calculations, com-

prehending the Friction of their Parts, and the other Accidents inſeperable from Practice; determining when they act upon inclined Planes, the Angle they ſhould form with the Horizon. In fine, comparing ſuch Machines as are contrived for the ſame Purpoſe, in order to diſcover which are to be preferred, according to the local Circumſtances and Conveniencies for their Execution.

HYDRAULICK ARCHITECTURE.

The Art of rendering Works capable of reſiſting the violent or ſlow Action of Water, preſents itſelf next; the various Machines made uſe of in draining, and of ſinking Piles, ſhould be deſcribed; then all that concerns the Conſtruction of Sluices, as alſo the Manner of employing them, according to the different Uſes to which they are applied, either in levelling the Canals of Navigation; draining of Marſhes; rendering Rivers navigable; forming artificial Inundations; making of Harbours, *&c.*

DRAUGHTING.

In order to render thoſe Reſearches of real Uſe to the young Officers, they ſhould be initiated in the Art of delineating Objects, as it teacheth how to repreſent all the Parts of Works already conſtructed, or that are intended to be conſtructed by Plans of them taken parallel to the Horizon, which ſhews the Diſtribution of all their Parts, their Dimenſions, *&c.* by Profiles or Cuts of them taken perpendicular to the Horizon, which ſhew the Heights, Situations, *&c.* of all the Parts, by Plans of Elevation, or Cuts of the exterior Parts of the Work; in fine, by perſpective Plans or Cuts, which repreſent the Object as ſeen at a certain Diſtance, which will enable them to judge of the Effect that all the Parts together produce.

ATTACK and DEFENCE.

Theſe Studies will prepare the young Officers for attaining to a proficiency in the Art of defending and attacking, which comprehend the Method of fortifying regular Poligons, according to the different Syſtems, ſhewing their Advantages with regard to the local Circumſtances, and how far they have been followed with ſucceſs in the Fortifications of the moſt celebrated Towns in *Europe*; the Conſtruction and Diſpoſition of Batteries, the management of Artillery, the pointing of Morters and Cannon, the conducting of Trenches, the manner of diſtributing the different Stages of Mines, the Form of their Excavation,

tion, the Rangement of the Chambers, the beſt contrived for the Huſbanding the Ground and the Annoyance of the Enemy, the Conſtruction of Lines and the Menſuration of their Parts, the Tracing of Camps, entrenched or not entrenched, in even or uneven Ground, the tracing of the Camps of Armies which beſiege, included in lines of Circumvallation and Contravallation, the Attack of a regular or irregular fortified Place, ſituated in an equal or unequal Ground, exemplified by the Plans of the moſt celebrated Sieges, joining Theory to Practice, neglecting not one Detail that may be of Importance. All theſe Opperations being made in large Demenſions, and a Front of Fortification being raiſed accompanied with the other detached Works to be attacked and defended as in a real Action.

GEOGRAPHY.

Geography as an Introduction to Hiſtory is uſeful to all Perſons, but the Profeſſion for which Youth is intended ſhould decide of the manner more or leſs Extenſive, it is to be taught; the young Officers ſhould have an exact Knowledge of the Countries which are commonly the Theatre of War they ſhould therefore be inſtructed in Topography in the greateſt Detail, employing the Method of refering to the different Places, the Paſſages in Hiſtory which may render it Remarkable, preferring the Military Facts to all others; by this Means their Notions will be more fixed, and their Memories, tho' more burthened, will become ſtronger.

HISTORY.

The Life of Man is inſufficient to ſtudy Hiſtory in Detail, the manner of teaching it ſhould therefore be adapted to the State of Life for which Youth is intended: thoſe who are deſtined for the Law, ſhould be taught it, as it ſerves to diſcover the Spirit and Syſtem of the Laws of which they will one Day be the Diſpenſers; thoſe who are intended for the Church, as it relates to Religion and the Eccleſiaſtic Diſcipline; the young Officers ſhould be taught it, as they may draw Inſtruction from the Military Details, as it furniſhes Examples of Virtue, Courage, Prudence, greatneſs of Soul, Attachment to their Country and Soveraign; they ſhould be made to remark in ancient Hiſtory that admirable Diſcipline, that Subordination which rendered a ſmall Number of Men the Maſters of the World; they ſhould be taught how to gather from the Hiſtory of their own Country, ſo neceſſary and ſo neglected, the preſent State of Affairs, the Rights of their King and Country, the Intereſt of other Countries and Soveraigns, &c.

TAC-

TACTICKS.

The Theory and Practice of the different Parts of the Military Service are neceſſary to all Officers, they ſhould be inſtructed in what regards the Service of Camps, the Service of Towns, Revews, Armaments, Equipments, &c. As to Military Exerciſes, and Evolutions, all who are acquainted with the actual State of the Military Affairs know how neceſſary it is to have a great Number of Officers ſufficiently inſtructed in the Art of Exerciſing Troops; it is manifeſt that a continual Practice is the ſureſt Means to attain to a Proficiency in this Art; the young Officers therefore ſhould be taught the Management of Arms, and trained up to the different Evolutions, which one Day they will make others execute.

ORDER of the STUDIES.

The Order that ſhould be followed in the Employ of the Day ſhould be ſuch, that the Variety and Succeſſion of Objects may ſerve as a Recreation, which is the moſt infaliable Means to haſten Inſtruction.

The Leſſons of Algebra, Geometry, Mechanicks, Hidroſtaticks, Hydraulicks, Geography, Hiſtory, &c. ſhould be firſt given, and thoſe on the various Branches of Drawing ſhould ſucceed.

PRACTICAL OPERATIONS.

As Youth is liable to take a Diſguſt againſt abſtract Knowledge, when its Application is not rendered ſenſible, the Teachers of Mathematicks and Drawing ſhould frequently put in Practice in the Field, the Mathematical, Mechanical, *&c.* Operations which are ſuſceptible, and which have been already delineated on Paper, Deſign at Sight, Views, Landſcapes, *&c.* this Method will have the Advantage of procuring the Pupils an Amuſement which will inſtruct them, and rendering palpable the Truths that have been preſented them, it will inſpire them at the ſame Time with a Deſire of learning new ones, and making them execute after Nature agreeable Operations, it will be a ſure Means of forming their Taſte.

PUBLICK EXAMINATIONS.

As the Inequality of Ages and Genius, and even of the good and bad Diſpoſitions of the greateſt Part of the Pupils, will cauſe a great Difference.

Difference. The State of the Examination ſhould be divided into three Claſſes. In the firſt ſhould be thoſe who diſtinguiſh themſelves the moſt by their Application; in the ſecond ſhould be compriſed thoſe who do their beſt; the third ſhould comprehend thoſe from whom little is expected. This State ſhould be laid before the Society, in order that it may have an exact Knowlege of the Progreſs of each.

CONCLUSION.

Such are the Means, my brave Countrymen, which the DUBLIN SOCIETY have in their Power to procure you, to enable you to ſtudy with Succeſs, how to eſtabliſh a Concert and an Harmony of Motion amongſt thoſe vaſt Bodies ſtiled Armies; how to combine all the Springs which ought to concur together; how to calculate the Activity of Forces, and the Time of Execution; how to take away from Fortune her Aſſendant, and enchain her by Prudence; how to ſeize on Poſts, and to defend them; how to profit of the Ground, and take away from the Enemy the Advantage of theirs; not to be dejected by Dangers, nor elated by Succeſs; how to retire, change the Plan of Operation; how in the Glance of an Eye to form the moſt diciſſive Reſolutions; how to ſeize with Tranquillity the rapid Inſtants which decide Victories, draw Advantages from the Faults of the Enemy; commit none, or what is greater, repair them, in which conſiſts the Art of War.

PLAN of the Merchantile Arts, including the Inſtructions relative to thoſe who are intended for Trade.

Docuit quæ maximus Atlas.

WISE Regulations and well concerted Encouragements will contribute very little to promote Trade, unleſs they be rendered practicable, operative, and uſeful, by the ſkill and addreſs of the judicious and induſtrious Trader; it is he who employs the Poor, rewards the Ingenious, encourages the Induſtrious, interchanges the Produce and Manufactures of one Country for thoſe of another, binds and links together in one Chain of Intereſt, the Univerſality of the human Species, and thus becomes a bleſſing to Mankind, a Credit to his Country, a Source of Affluence to all around him, his Family, and himſelf. The Extent of Knowledge and Abilities notwithſtanding, requiſite to fit Youth for ſo great and valuable Purpoſes, have not been attended to in this Country, and thoſe of the

the commercial Profeſſion labour under the ſame Diſadvantages Point of Education, as the different claſſes of Men we have already ſpoke of.

The Diſadvantages in Point of Education thoſe of the commercial Profeſſion labour under.

A number of Years are ſpent and frequently loſt in drudging through the common Forms of a Grammar School, where Youth are obliged to learn what is dark and difficult, and what muſt afterwards coſt them much Pains to unlearn, and if long purſued muſt in the End retard the quickeſt Parts, and go near to eclipſe the brighteſt Genius: whilſt on the contrary, if the Grammar School Studies were properly directed and carefully purſued, they would learn to paſs a proper Judgment on what they read, with regard to Language, Thoughts, Reflections, Principles, and Facts, to admire and imitate the Solid more than the Bright, the True more than the Marvellous, the perſonal Merit and good Senſe more than the external and Adventitious; their Taſte for Writing and Living might be in ſome Meaſure formed, their Judgment rectified, the firſt Principles of Honour and Equity inſtilled, the Love of Virtue and Abhorrence of Vice excited in their Minds: *quare ergo liberalibus Studiis Filios erudimus? non quia Virtutem dare poſſunt, ſed quia Animum ad accipiendam Virtutem præparant, quemadmodum prima illa ut Antiqui vocabant, Literatura, per quam pueris Elementa traduntur, non docet liberales Artes, ſed mox percipiendis Locum parat, ſic liberales Artes non perducunt Animum ad Virtutem, ſed expediunt.* At a certain Age, not after certain Acquiſitions, a Maſter of Mathematicks is looked out for, and in this Caſe great Pretenſions, atteſted by his own Word, and low Prices, are ſufficient Credentials to recommend him, although neither the Teacher nor the Student reap much Advantage, from it. When the round of this Teacher's Form is once finiſhed, the Student is then turned over to the compting Houſe, where he is employed during the time of his Apprenticeſhip in Copying Letters, going Meſſages, and waiting on the Poſt Office. The Maſter though he hath Talents for communicating, hath not Time for attending to the Inſtruction of an Apprentice, who on the other hand hath been ſo little accuſtomed to think, that his Improvement by ſelf Application will be very inconſiderable, beſides his Time of Life, and conſtant habit of Indulgence, render him more ſuſceptible of pleaſurable Impreſſions, than of Improvement in Buſineſs, the more eſpecially when he was not previouſly prepared to underſtand it; where-

fore

fore it is not at all ſurpriſing if many, who having no Foundation in Knowledge to qualify them for the Compting Houſe, profit little from the Expence and Time of an Apprenticeſhip, and from ſeeing Buſineſs conducted with all the Skill and Addreſs of the moſt accompliſhed Merchant: The Conſequence muſt no doubt be fatal to Numbers, and the Public Intereſt, as well as Private, muſt ſuffer greatly by every Inſtance of this Nature. It is True that there have been and ſtill are Gentlemen, who deſtitute of all previous mercantile Inſtruction, without Money and without Friends, by the uncommon Strength of natural Abilities, ſupported only by their own indefatigable Induſtry and Application, and perhaps favoured with an extraordinary Series of fortunate Events, have acquired great Eſtates; but ſuch Inſtances are rare, and rather to be admired than imitated; for we ſee many ſet out with large Capitals, who have ſhone in the commercial World while their Capitals laſted, as Meteors do in the natural, but like them ſoon deſtroyed themſelves, and involved in their Ruin all ſuch who were ſo unhappy as to be within the Sphere of their Influence. *Novimus novitios, qui cum ſe mercaturæ vix dederunt, in magnis mercimoniis ſe implicantes, rem ſuam male geſſiſſe; et profecto imperitos mercatores, multis captionibus ſuppoſitos, multumque inſidiis expoſitos experientia videmus.*

The Neceſſity of erecting a Mercantile School.

Commerce is not a Game of Chance, but a Science, in which he who is moſt ſkilled bids faireſt for Succeſs, whereas the Man who ſhoots at random, and leaves the Direction to Fortune may go miſerably wide of the Mark; the People of this Country therefore ought by no means to truſt the future Proſpects of their Children in the World to a Foundation ſo weak and uncertain: but ſetting that Value on Education, which they do upon Trifles, be as careful in having the Minds of their Children adorned with Virtue and good Senſe, as they are in ſetting of every thing which relates to their Bodies. A School ſhould be erected in this Kingdom for training up Youth to Buſineſs, where every maſter ſhould have a Salary proportioned to to the Difficulty of his Department: the moſt intelligent Traders being appointed the Superintendants of this School, who ſhould take care that none ſhould be admitted whoſe Parts were not previouſly enquired into, and whoſe Genius was not in ſome meaſure turned to act with Dignity in the mercantile Profeſſion; who ſhould enquire often into the Morals and Proficiency of the Students, converſe frequently with the Maſters on the Subject of Trade, and admit the

Students according to their Seniority in Letters to ſuch Converſations; and in ſhort take every other Method of encouraging both Maſters and Students to Induſtry and Attention, that they may go through the tedious and difficult Taſk with Alacrity and Spirit. By theſe means our Youth would be long acquainted with the Arts of gaining; before they would learn to ſpend Money, they would not be grown Old in Debauchery and Riot before they were initiated into Buſineſs, and we would ſoon ſee a Spirit of Induſtry, Knowledge, Humanity, and good Senſe, diffuſe itſelf among all Ranks, and Denominations, whilſt Idleneſs and Folly, with all their miſchiveous Train, would be baniſhed our Streets,

ORDER of the STUDIES.

MATHEMATICKS and DRAWING.

In this School the young Merchant ſhould be firſt brought acquainted with Aritmetick, numerous and ſpecious, which of all other Sciences is the moſt neceſſary to the mercantile Profeſſion, the Teaching of which requires much Skill and Knowledge. before it ſhould be applied to Computations in Buſineſs every Rule ſhould be demonſtrated, exemplified, and illuſtrated, in an eaſy intelligible Manner, and the Examples ſo multiplied and diverſified, that the Learner may be thorougly grounded, and have Reaſon always ready for what he does: All the various Compendiums which ſerve to abreviate Operations ſhould be diſtinctly ſhewn and demonſtrated: That Facility and Diſpatch may be equally familiar, Theory then ſhould be reduced to Practice, in all the Caſes which can occur to the Merchant, the Banker, the Cuſtom Houſe, and Inſurance Office, to which every Obſervation relative to Inſurance, Factorage, Exchange, and ſuch other Branches of Buſineſs ſhould be joined, which will ſerve to illuſtrate the Uſe of the different Examples. This will not only form the Mind of the young Merchant to Buſineſs, but when he comes to act for himſelf will prevent many tedious and expenſive Suits, which an Ignorance in the practical Arts of Negotiating them is frequently apt to create.

He ſhould then be initiated in Geometry, Elementary, Tranſcendental, and Sublime, which of all other Studies contribute moſt to invigorate the Mind, to free it from Prejudices, Credulity, Superſtition, and to accuſtom it to attention and demonſtrative Reaſoning: the Theory ſhould be rednced to practice in the Menſuration of Surfaces and Solids, Heights and Diſtances, and in Conſtructing the Inſtruments

ſtruments he hath Occaſion to uſe in laying down Plans and Maps of Countries, ſelling Land by Meaſure, aſcertaining the Price of Labour, and determining the Quantity of Liquors, for regulating of their Price and Duty, &c. ſome Proficiency in the different Branches of Drawing will enable him to carry into Excution theſe practical Operations.

GEOGRAPHY and HISTORY.

The young Merchant ſhould be inſtructed in the Uſe of the Globes, Maps, &c. and brought acquainted with the Situation, Extent, Produce, Manufactures, Commerce, Ports, Policies, and Regulations with reſpect to Trade of all the Nations in the World; how the ſeveral Parts of the World are connected together in their mutual Intercourſe of Commerce, how the Redundancies of one Country ſupplies the Wants of another, in what Articles the Markets are ſcarce, and in what they are overſtocked, which will enable him at all Times to foreſee when any Branch of Trade in which he is concerned is likely to be ſtagnated, and to take his Meaſures accordingly for preventing the bad Conſequences; the national Commerce in general, the Trade of the Place where he lives, the Laws, Cuſtoms, and Uſuages, relative to the Buſineſs of the Merchant, the Penalties to which he is lyable, and the Privileges to which he is intitled; the Duties, Impoſts, and other Charges, laid upon the Produce of theſe Iſlands in other Countries, with all the known Maxims that relate to the Proſperity of Trade, will open alſo a wide Field for Improvement in Matters of real Uſe.

NAVIGATION.

Naval Architecture will teach the young Merchant the principle Parts of the Veſſel and their Proportions, the Demenſions of her Bottom, the Curviture of her Flanks, the Sally of her Stem, &c. how to form the Plan of a ſhip, how to diſcover by Calculation whether the Veſſel conſtructed according to the Device will have the Qualities requiſit to her Deſtination, whether the Wait is propotioned to the Solidity of her Bottom, her Stability to the Quantity of Sail ſhe is to carry, the Rapidity of her Motion to her Capacity: the Method of gauging Veſſels, how to regulate the Duties on Anchorage, and other Duties of the ſame Species, &c.

The young Merchant ſhould alſo be brought acquainted with the Uſe of the Sea Compaſs, the Conſtruction and Uſe of Sea Charts, the Principles of Aſtronomy applied for finding the Latitude, the

Variation of the Compaſs and Longitude at Sea ; in fine the manner of ſolving the different Problems relative to Navigation by Graphical Operations and Calculation.

MORAL PHILOSOPHY.

It will be of little Conſequence to have the Underſtanding improved, if the Heart be totally neglected ; Man was made by Nature for Society, but the Merchant both by Nature and Practice ; The young Merchant therefore ſhould be taught the Nature and Eſſence of Good, its Principles, Powers, and Effects, how to blend ſelf Love with Benevolence, to moderate his Paſſions, to ſubject all his Actions to the Teſt of Reaſon, and that it is his Duty and Intereſt to found all his dealings on Integrity and Honour, as he that accuſtoms himſelf to unfair Dealing will by degrees be reconciled to every Species of Fraud, till Ruin and Infamy become the Conſequence.

The Principle of Law and Government ought likwiſe to conſtitute a Part of the mercantile Plan of Inſtruction, by which they will learn to whom Obedience is due, for what it is paid, and in what Degree it may juſtly be required ; and to give proper Inſtructions to their Repreſentatives in the great Council of the Nation when they are deliberating on any Act which may be detrimental to the Intereſt of the Community with reſpect to Commerce, or any other Privilege whatſoever.

COMPOSITION.

The Study of Compoſition will not only teach but accuſtom the young Merchant to range his Thoughts, Arguments, and Proofs, in a proper Order, and to cloath them in that Dreſs, which Circumſtances render moſt Natural ; by this means he will not only be able to read the Works of the beſt Authors with Taſte and Propriety, to obſerve the Elegance, Juſtneſs, Force, and Delicacy of the Turns and Expreſſions, and ſtill more the Truth and Solidity of the Thoughts ; hereby will the Connection, Diſpoſition, Force, and Gradation of the different Proofs of a Diſcourſe be obvious and familiar to him, while at the ſame Time he is led by degrees to ſpeak and write with Freedom and Elegance, which will infallibly raiſe the Opinion of the young Merchant in the Eye of his Correſpondents, and of the Public.

BOOK-KEEPING.

A Merchant ought to know upon all Occcaſions what is in his Power to do without embarriſing himſelf, and have ſuch an Idea of his Dealings, and thoſe with whom he deals, that his Speculations may be always within his Sphere, to effect which the Method of arrainging and adjuſting Merchants Tranſactions muſt, like other Sciences, be communicated in a rational and demonſtrative Manner, and not mechanically by Rules depending on the Memory alone. The Principles upon which the Science is founded muſt likewiſe be reduced to Practice by proper Examples in forreign and domeſtic Tranſactions, ſuch as buying and ſelling, importing, exporting, for proper, Company, and Commiſſion, Account, Drawing, and Remiting to, freighting and hiring Veſſels for different Parts of the World, making Inſurances and Underwritings, and the various other Articles that may be ſuppoſed to diverſify the Buſineſs of the practical Compting Houſe. the Nature of all thoſe Tranſactions, and the Manner of Negotiating them, ought to be particularly explained as they occur: the Forms of Invoices and Bills of Sales, together with the Nature of all intermediate Accounts, which may be made uſe of to anſwer particular Purpoſes, ought to be laid open: and the Form of all ſuch Writs as may be ſuppoſed to have been connected with the Tranſactions in the waſte Book ſhould be rendered ſo familiar that the young Merchant may be able to make them out at once without the Aſſiſtance of Copies.

PRACTICAL NEGOTIATIONS.

In Order to accuſtom the young Merchants to think, write, and act, like Men before they come upon the real Stage of Acton, an Epiſtolary Correſpondence ſhould be eſtabliſhed among them, as it would accuſtom them to digeſt well what ever they read, and improve their Diction under the Correction of an accurate Maſter to that clear, pointed, and conſice Manner of Writing which ought particularly to diſtinguiſh a Merchant: Fictitious Differences among Merchants ſhould likewiſe be ſubmitted to their Judgment, ſometimes to two by the way of Arbitration, and again to a Jury, whilſt one would aſſume the Character of the Plaintiff and another that of the Defendant, and each give in ſuch Memorials or Repreſentations, according to the Nature of the Facts diſcuſſed, as he thinks moſt proper to ſupport the Cauſe, the Patronage of which was aſſigned him.

CON-

CONCLUSION.

When the Education of the young Merchant is thus conducted, his Knowledge will be ſo particular, and his Morals ſo ſecured, that he will be proof againſt the Arts of the deceitful, the Snares of the diſingenious, and the Temptations of the wicked; he will in a ſhort Time be ſo expert in every part of the Buſineſs of the practical counting Houſe, that when he comes to act for himſelf every Advantage in Trade will lie open to him, his Knowledge, Skill, and Addreſs, will carry him through all Obſtacles to his Advancement, his Talents will ſupply the Place of a large Capital, and when the beaten Track of Buſineſs becomes leſs Advantageous, by being in too many Hands, he will ſtrike out new Paths for himſelf, and thus bring a Ballance of Wealth, not only to himſelf, but to the Community with which he is connected, by Branches of Trade unknown before.

PLAN of the Naval Art: Including the Inſtructions relative to Ship-Builders, Sea-Officers, and in general to all thoſe who are any way concerned in the Buſineſs of the Sea.

Qui dubiis auſus committere fluctibus Alnum
Quas Natura negat, præbuit Arte Vias.

Claud.

AS nothing is executed in the Military Way, but by the Direction of Geometry and Mechanicks, no leſs indiſpenſible is the Uſe of theſe Sciences in Naval Operations, *viz.* Ship-Building, Stowing, working, and conducting Veſſels through the Sea. A Ship is ſo complicated a Machine, its various Parts have ſo cloſe and ſo hidden a Dependance on one another, and the Qualities it ought to be endued with, are ſo many in Number, and ſo difficult to be reconciled, the Mechaniſm of its Motions depends upon ſo many Inſtruments, which have an eſſential Relation to each other, *&c.* that it is only by Experience, aided by the ſublimeſt Geometry, it has been diſcovered, that all its Actions are ſubjected to invariable Laws, and that we can attain to certain Rules, which could enable the Maſter Ship-Builders to give their Veſſels the moſt advantageous Forms, relative to the Services for which they are deſtined, and inſtruct the Navigator how to draw from the Wind the greateſt Force, to diſpoſe of it at Pleaſure, and to traverſe the vaſteſt

vaſteſt Seas without Danger and without Fear. Nevertheleſs, Mathematicks reduced by the Teachers of them in this Kingdom, to a few groſs practical Rules, their Application to Sea Affairs, and to all other uſeful Enterpriſes, has not as yet been introduced; this Neglect has not only retarded the Progreſs that the Study of Mathematicks otherwiſe would have made, by hindering it from being known that they are the Means the moſt proper to ſupply the Limitation of our natural Faculties, and that it is from them that all uſeful Arts are to receive their Perfection. But in the preſent Caſe cannot but be attended with the moſt fatal Conſequences, and the Diſaſters that happen but too often at Sea, are undoubtedly in a great Meaſure owing to it.

NAVAL ARCHITECTURE.

The Conſtructing and Repairing of Veſſels is entirely abandoned to the Direction of Ship-Carpenters, whoſe Knowledge is confined to a few groſs obſcure Rules, which leave the Diſpoſition of almoſt all the Work to Chance, or to the Caprice of Workmen; they rely in the moſt important Circumſtances, on the blindeſt Practice, on that which is the moſt liable to Error; they change the Form of the upper Part of the Ship, they add a new Deck, or take one away, they alter totally the Form of her Bottom, *&c.*

Making all thoſe Changes, without knowing what Effects will enſue, even thoſe that would manifeſt themſelves in the Harbour, though they could determine them after the moſt infallible and preciſe Manner, in employing the leaſt Knowledge of Geometry, and the ſimpleſt Operations of Arithmetick: And if they were taught the Nature of Fluids, and the Mecaniſm of Floating Bodies, how to conſider the Ship as a phiſical heterogeneous Body in all its different Situations, and relative to its different Uſes; repreſenting it to themſelves not only when it is loaden, and at Anchor, but alſo when it ſails, when it goes well, doubles a Cape, gets difficultly clear of a Coaſt, *&c.* then Geometry and Mechanicks taking the Place that Chance and blind Practice had uſurped, Maſter Shipbuilders would exerciſe their Employments with Diſcernment; ſubſtituting luminous and preciſe Rules in the Place of their imperfect practical ones; they would be no more expoſed to the Trouble and Shame of attempting any thing raſhly, but would be enabled to aſſign and foreſee the Succeſs of their Enterpriſes, and producing no Plans but what were ſupported by juſtifiable Calculations, in which each Quality the Ship ought to have, would be diſcuſſed and eſtimated with Exactneſs; we could

ſee

ſee, in verifying their Calculations, what Streſs could be laid upon their Promiſes; we would have infallible Means of deciding in Favour of the different Plans propoſed for the ſame Ship and the Multitude of their Opinions, far from being hurtful, would on the contrary be profitable, ſince it would often furniſh an Occaſion of making a better Choice.

MECHANICAL NAVIGATION.

The Ship being built, it is the Buſineſs of the Navigator to diſtribute the Loading in ſuch a Manner that ſhe may ſail without Danger, and at the ſame Time receive with the greateſt Facility whatever Motions are to be given her, that is, he is to diſcover her moſt eligible Poſition in the Water, he is to diſpoſe her Sails after a ſuitable Manner to oblige the Veſſel to take the Route he intends to follow upon all Occaſions, and to make her go well in ſpight of the Agitation of the Sea, and the Violence of the Wind, which often oppoſes; for this Effect, in a Glance of an Eye, he muſt be capable of rendering preſent to his Mind all the moveable Parts of the Ship, which he muſt lo k upon as a Body which he animates as he does his own, and that it is as it were an Extention of it; ſeize the actual State of Things in their continual Change, and form the moſt deciſive Reſolutions, which he muſt draw from no other Fund but his own Breaſt. This is without Doubt the moſt difficult Part of the Navigator's Art, but at the ſame Time the moſt important for him to poſſeſs, as it furniſhes him with the ſureſt Reſources in immergent Occaſions, and renders him ſuperior in Battle: It is ſurpriſing with what Readineſs the Ship well diſpoſed, obeys as it were the Orders of the ſkilful Seaman; but on the contrary, if he does not know all the Nicity of this Part of his Art, his Ship, though excellent, is no more but a heavy Maſs, which receives all its Motions from the Caprice of the Wind and Weaves, which in ſpight of his Courage and deſperate Efforts, becomes but too ſurely a Prey to the Enemy, or ends very ſoon its Deſtiny by Shipwreck.

Notwithſtanding no Attempt has been made in this Kingdom to leſſen the Difficulty of attaining to a Proficiency in this Branch of the Naval Art, by inſtructing Seamen in it after a methodical Manner, it is entirely abandoned to blind Practice, as if it could not be ſubjected to exact Rules in the Employ of the Phiſical Means which it makes uſe of to move the Veſſel. When a Maneuvre is executed in the Preſence of a young Seaman, he does not know very often for what it is done, or how the Inſtruments that are made uſe of, act; he is ſurrounded with Perſons too buiſy to give him the leaſt

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Eclairciſement; we may judge from thence how much Time he muſt loſe to learn theſe groſs Notions, which are to ſerve him inſtead of Theory: The imperfect Knowledge which the young Seamen will attain to, will be to the Diſgrace of human Reaſon, the Fruit of many Years unwearied Labour; and nevertheleſs, as it will ſavour of its defective Origin, it will not give him ſufficient Inſight, and will leave him without exact Rules, which he can abſolutely rely upon; he will give, for Example, a certain Obliquity to the Sails; he will receive the Wind with a determined Incidence, but will he know whether there is nothing to be changed in one Senſe or the other, in one or the other Diſpoſition, his only Rule is Servily to Copy, what he has ſeen practiſed perhaps erroneouſly by others on like Occaſions; let him on the contrary, be methodically inſtructed in the uſeful Maxims of the Doctrine of the moveable Forces, applied to the Buſineſs of the Sea, and let him render them familiar to himſelf in taking Share in all the Maneuvres he will ſee executed, in order to apply them mechanically, without the painful Help of Reflection; he will then ſee nothing for which he will not be prepared beforehand, and of which he could give an Explication to himſelf; and as he would not be obliged to execute any Maneuvre blindly, he will be ſenſible of the happy Effects that a reflected Exerciſe can produce, and the Quality of a good Practitioner would be leſs difficult to acquire.

The ART of PILOTING.

The Navigator not only ought to know how to produce the different Motions of the Ship, but he is to obſerve all the Particularities of its Rout, eſteem its daily Poſition, and the Courſe he is to ſteer, to arrive at the Harbour where he is to go: This is the only Branch of the Naval Art that is taught by Rule; but it is a general Complaint among Seamen, that very little of what is learned in Schools, is of real Uſe; which contributes very much to confirm them in the dangerous Error, that Theory is of little or no Service; this proceeds from the Generality of Teachers having no Practice of the Sea, do not conform their Plans of Teaching to the Exigencies of Seamen, in ſhewing them how to modify their Rules of Navigation, according to the different Caſes of Sailing; how to reduce to the ſmalleſt Compaſs, the Errors to which the Meaſures made uſe of for determining the Courſe and Diſtance, are liable to, and how to make proper Allowances for them, which would enable them, as often as the Reckoning would not agree with the Obſervation, to

udge on which Side lay the Error, and conſequently how to correct t; all which ſuppoſes in the Teacher a profound Knowledge of the Theory of the Art (*See* the Memoirs of the Academy of *Paris*, for the Year 1753) and a perfect Knowledge of all the Circumſtances of the Ship's Motion, in all Caſes of Wind and Weather.

Their not being ſufficiently exerciſed in Aſtronomy and Aſtronomical Obſervations, make them neglect inſtructing Seamen how to chuſe the moſt favourable Circumſtances for obſerving either by Night or Day. The only Obſervations practiſed by Seamen, are the Sun's meridional Height, and its Setting; they are entirely unacquainted with the Stars, though their Obſervations could be of great Uſe, particularly when the Sun does not ſerve, being obſerveable at all Hours of the Night, and the Incertitude to which the reckoning is liable to, demands that the Seamen ſhould let no Occaſion ſlip of taking Obſervations every Day; moreover the moſt reaſonable Hopes of determining the Longitude at Sea, is founded on the Obſervation of the Diſtance of the Moon to a Star, or to the Sun; this Method gives actually the Longitude to half a Degree, and has the Advantage of being as eaſy put in Practice, as that for determining the Latitude. If they had a little Skill in Aſtronomical Obſervations, they could determine the Poſitions of ſo many Places, even of this Kingdom, which are placed in Charts after an uncertain Eſtimation; but on the contrary, they do not know even how to verify the Inſtruments that are in Uſe at Sea, particularly their Compaſſes and Quadrants; for want of ſuch a Knowledge, they are obliged to take them upon the bare Word of the Workman, who is intereſted to get them off his Hands at any Rate; and though they ought to be verified every Voyage, on account of the Accidents that might ariſe to them; it is not done: This Particular, however minute, nevertheleſs is worthy of Attention, ſince nothing ſhould be neglected in the preſent Caſe, ſeeing, in ſpight of all the Care that can be taken, the Errors that are committed being but too ſenſible, and as great ones may be occaſioned in the Reckoning by the Imperfection of the Inſtruments, as in Deductions deduced from Calculation: We may conclude from theſe Conſiderations, that the Shipbuilders and Navigators of this Kingdom are no way appriſed of the important Reſources they could draw from Geometry and Mechanicks, though in no Profeſſion ſo eminent as in theirs, and that they will never be ſufficiently ſkilled in their reſpective Arts, until Perſons be appointed in the different Sea-port Towns, exerciſed ſufficiently in the ſublime Mathematicks, as to be able to underſtand the different Mathematical Tracts that

have

have been publiſhed in great Numbers of late Years, upon the different Branches of the Naval Art, ſuch as Ship-building, Stowing, working Veſſels at Sea, *&c.* by the moſt eminent Mathematicians of *Europe*, who ſhall make it their Buſineſs to communicate to them after a Methodical Manner, all the Improvements their reſpective Arts have received, and receive daily from Mathematicks.

DRAUGHTING.

They ſhould be aided in this important Employment by Drawing-Maſters, as the Ship-builders cannot finiſh properly their Plans, without a Tincture of this Art, and ſome Proficiency in it, would enable the Navigator to take Views of Lands, draw ſuch Coaſts, and plan ſuch Harbours, as the Ship ſhould touch at, which would contribute very much to render the Geography of our Globe more correct, and leſſen the Danger of Navigations; but what is perhaps of more Conſequence, it would make them acquire the Habit of obſerving Objects with Diſtinctneſs, and recollect exactly every Part of them, and recall all the Circumſtances of their Appearances. In one Word, as the Science, which is entirely occupied in weighing, meaſuring and comparing Magnitudes, is neceſſary in all Stations and Occurrences of Life, ſo the Art which repreſents them to the Eye is indiſpenſible.

CONCLUSION.

Theſe Informations, I hope, will be favourably received by the Honourable Members of the DUBLIN-SOCIETY, who are always attentive to what may contribute to the Publick Good. A Drawing-School is already erected by their Bounty in this City, where Youth are inſtructed in all the uſeful Branches of that Art, by able Maſters; if therefore a Maſter was appointed to teach in this School Mathematicks, as far as they are applicable to Matters relating to uſeful Arts, ſuch as Agriculture and Commerce, this Eſtabliſhment would not only ſuit the Purpoſes of all thoſe any way concerned in the Buſineſs of the Sea, but of all other Perſons, for whatever Station of Life they may be deſtined.

AN

*AN EXTRACT * from the Plan of the School of mechanic Arts, under the Direction of the Royal Academy of Sciences at* Paris, *where all Artiſts, ſuch as Architects, Painters, Sculptors Engravors, &c. Clock makers, Jewellers, Gold-Smiths, &c. receive the inſtructions in Geometry, Perſpective, Staticks, Dynamicks, Phiſicks, &c. which ſuit their reſpective Profeſſions, and may contribute to improve their Taſte and their Talents.*

Rem quam ago, non opinionem ſed opus eſſe, eamque non Sectæ alicujus aut placiti, ſed utilitatis eſſe et amplitudinis immenſæ fundamenta.
Bacon.

HOwever vigorous, indefatigable, or ſupple, is the naked Hand of Man, it is capable of producing but a ſmall Number of Effects. He can perform great matters but by the help of Inſtruments and Rules, which are as Muſcles ſuperadded to his Arms. The different Syſtems of Inſtruments and Rules conſpiring to the ſame End, hitherto invented to impreſs certain Forms on the Productions of Nature, either to ſupply our Wants, our Pleaſures, our Amuſements, our Curioſity, &c. conſtitute the mechanic Arts.

Every Art has its Theory and Practice; its Theory is grounded on Geometry, Perſpective, Staticks, Dynamicks, whoſe Precepts corrected by thoſe of Phiſicks, as it procures the Knowledge of the Materials, their Qualities, Elaſticity, Inflexibility, Friction, the Effects of the Air, Water, Cold, Heat, Aridity, *&c.* produce the Rules and Inſtruments of the Art. Practice is the habitual Uſe of thoſe Inſtruments and Rules.

It is ſcarce poſſible to improve the Practice without Theory, and reciprocally to be Maſter of the Theory without Practice, as there is in every Art a great Number of Circumſtances relative to the Materials, to the Inſtruments, and to the Operation which can be learned only by Uſe. It is the Buſineſs of Practice to point out the Difficulties, and to furniſh the Phenomena. It is the Buſineſs of the Theory to explain the Phenomena, to remove Difficulties and to open the Road to further Improvement: from whence it follows, that only ſuch Artiſts who have a competent Knowledge of the Theory, can become eminent in their Profeſſion.

But

* This Plan, being too extenſive, is omitted for the preſent.

But unfortunately ſuch is the Influence of Prejudice in this Country, that Artiſts, Mechanicks, *&c.* are conſidered as incapable of acquiring any Knowledge in the Principles of their reſpective Profeſſions, and our Youth deſtined to receive a liberal Education, are taught to think it beneath them to give a conſtant Application to Experiments and particular ſenſible Objects, for to practice or even to Study the mechanic Arts is to ſtoop to Things whoſe Reſearch is Laborious, the Meditation ignoble, the Expoſition difficult, the Exerciſe diſhonourable, the Number endleſs, and the Value inconſiderable. Prejudice which has debaſed an uſeful and eſtimable Claſs of Men, and peopled our Towns with arrogant Reaſoners, uſeleſs Contemplators; and the Country with idle and haughty Landlords.

The Judicious without doubt are as ſenſible of the Injuſtice as of the fatal Conſequences attending this Contempt for the mechanic Arts: the Induſtry of the People and the Eſtabliſhment of Manufactures being the moſt aſſured Riches of this Country. Let us therefore render that Juſtice to the Artiſts, which is due to them, let us raiſe the mechanic Arts from that State of Meaneſs, which Prejudice has hitherto kept them; let the Ptotection of the Noblemen and Gentlemen of Fortune ſecure the Artiſts and Mechanicks from that Indigence in which they languiſh. They have thought themſelves contemptible becauſe they have been deſpiſed: let us teach them to have a better Opinion of themſelves, it is the only means of obtaining from them more perfect Productions.

Let a School of mechanic Arts be eſtabliſhed, where all the Phenomena of the Arts ſhall be aſſembled, which will determine the Artiſts to ſtudy, teach the men of Genius to think uſefully, and the Opulent to make a proper Uſe of their Authority and their Rewards. There the Artiſts will receive the Inſtructions they will ſtand in need of, they will be delivered from a number of Prejudices, particularly that from which ſcarce any are free, of Imagining that their Art has acquired the laſt Degree of Perfection; their narrow Views expoſing them often to attribute, to the Nature of Things, Defects which ariſe wholly from themſelves; Difficulties appearing to them unſurmountable, when they are ignorant of the Means of removing them. They will be rendered capable of reflecting and combining, and of finding, in fine, the only Means of excelling; the Means of ſaving the Matter, and the Time, of aiding Induſtry, either by a new Machine, or by a more commodious Method of Working.

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There Experiments will be made, to advance whoſe Succeſs, every one will contribute; the Ingenious will direct, the Artiſt will execute; and the Man of Fortune will defray the Expence of the materials, Labour, and Time. There Inſpectors will be appointed, who will take care that good Stuff is employed in our Manufactures, and that they are properly ſupplied with Hands; that each Operation employs a different Man, and that each Workman ſhall do, during his Life, but one Thing only; from whence it will reſult, that each will be well and expeditiouſly executed, and the beſt Work will be alſo the Cheapeſt. Thus in a ſhort Time our Arts and Manufactures will be brought to as great a Degree of Perfection, as in any other Part of *Europe*.

FINIS.

SPECIMEN

OF

Elementary Geometry.

BEING the firſt Part of the Courſe of pure Mathematicks intended for the Uſe of the Drawing School eſtabliſhed under the Inſpection of the Dublin Society, where it is propoſed to procure to the Youth of this Kingdom, the Inſtructions neceſſary to enable them to become Proficients in the different Branches of that Art, and to purſue with Succeſs either Geographical, Nautical, Mechanical, Commercial, or Military Studies.

PREFACE.

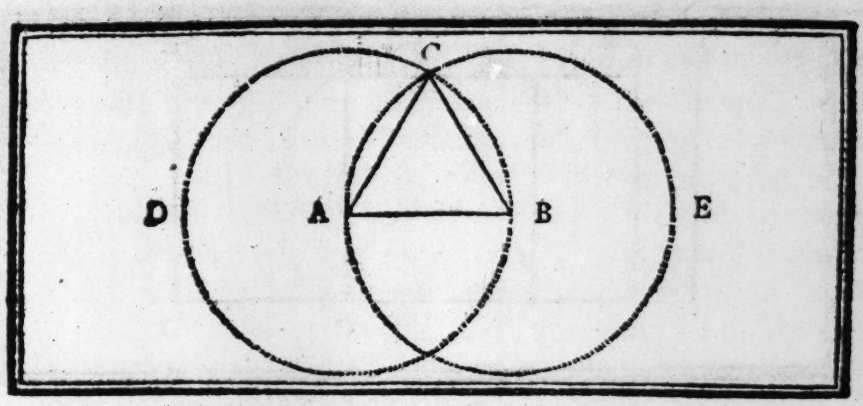
THE Deſign of theſe new Elements being to open to Youth an accurate and eaſy Method for acquiring a knowledge in Geometry, all the Propoſitions in *Euclid*, in the Order they are found in the beſt Editions, have been retained with all poſſible Attention, as alſo the Form, Connection, and Accuracy of his Demonſtrations. The eſſential Parts of his Propoſitions being ſet forth with all the clearneſs imaginable, the Senſe of his Reaſonings are explained and placed in ſo advantageous a Light, that the Eye the leaſt attentive may perceive them. To render theſe Elements ſtill more eaſy, the different Operations and Arguments eſſential to a good Demonſtration, are diſtinguiſhed in ſeveral ſeparate Articles.

To

To make a Progreſs in the Study of the Mathematicks, Beginners ſhould apply themſelves chiefly to diſcover the Connection and Relation of the different Propoſitions, to form a juſt Idea of the Number and Qualities of the Arguments which ſerve to eſtabliſh a new Truth, in fine, to diſcover all the intrinſical Parts of a Demonſtration. But as it is Impoſſible to acquire theſe Notions without knowing what enters into the Compoſition of a Theorem and Problem: Firſt, The Preparation and Demonſtration are diſtinguiſhed from each other. Secondly, The Propoſition being ſet down, what is ſuppoſed in this Propoſition is made known under the Title of Hypotheſis, and what is Affirmed, under that of Theſis. Thirdly, All the Operations neceſſary to make known Truths, ſerve as a Proof to an unknown one, are ranged in ſeparate Articles. Fourthly, The Foundations of each Propoſition relative to the Figure which Form the minor of the Argument, are made known by Citations, and a marginal Citation recalls the Truths already demonſtrated, which is the major: In one Word, nothing has been omitted which may fix the Attention of Beginners, make them perceive the Chain, and teach them to follow the Thread of Geometrical reaſoning.

Explication of the Signs and Abbreviations.

⊥ Perpendicular.
∠ Greater than
⩤ Leſs than
— Leſs
⌟ Right Angle
= Equal
+ More.
pgr. Parallelogram
□ Square.
⊙ Circle
○ Circonference
∀ Angle
△ Triangle
plle. Parallel
rgle. Rectangle



PROPOSITION I. Problem I.

TO deſcribe an equilateral Triangle (A B C) upon a given ſtraight Line (AB)

Given	Sought
a ſtraight Line A B.	*the Conſtruction of an equilateral* △ *upon a ſtraight Line A B.*

Reſolution.

1. From the Point A as Center, and with the Ray AB deſcribe ⊙ BCD *Poſ.* 3.
2. From the Point B as Center, and with the Ray B A deſcribe ⊙ ACE. *Poſ.* 3.
3. Mark the Point of Interſection C.
4. From the Point A to the Point C, draw the ſtraight Line A C. *Poſ.* 1.
5. From the Point B to the Point C, draw the ſtraight Line B C. *Poſ.* 1.

DEMONSTRATION.

Becauſe the Point A is the Center of ⊙ BCD (*Reſ.* 1) and the Lines AB AC are drawn from the Center to the ○ BCD (*Reſ.* 4)

1. Thoſe two Lines AB, AC are Rays of the ſame ⊙. *D.* 16 *B.* 1
2. Conſequently the Line AC is = to the Line AB. *D.* 15 *B.* 1

And becauſe the Point B is the Center of ⊙ A C E (*Reſ.* 2) and the Lines BA, BC are drawn from the Center B to ○ ACE (*Reſ.* 5.)

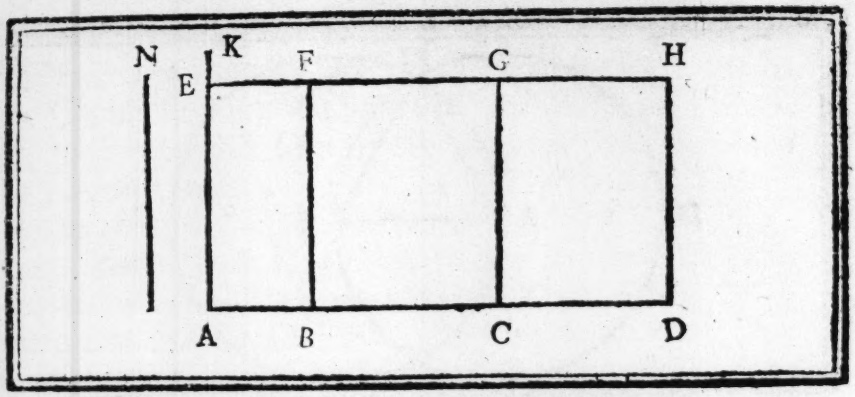
3. Thoſe two Lines are alſo Rays of the ſame Circle ACE. *D.* 16 *B.* 1
4. And the Line BC is alſo = to the ſame Line AB. *D.* 15 *B.* 1
5. The Lines AC, BC are therefore = to the ſame 3d Line AB. (*Ax* 2&4)

But if two Quantities are equal to the ſame third, they are equal to one another. *Ax.* 1.

6. The Line AC is therefore = to the Line BC.

But each of thoſe two Lines = to one another (*Ax.* 6.) is alſo = to the Line AB. (*Arg.* 5.)

7. Wherefore the Lines AB, BC, AC, which form the Sides of △ ABC are equal to one another.
8. Conſequently the Triangle ABC conſtructed upon the given ſtraight Line AB is an equilateral Triangle. Which was required to be done. *D.* 24 *B.* 1



PROPOSITION I. Theorem I.

IF there be two ſtraight Lines AD and N, one of which (as AD) is divided into any Number of Parts (AB,BC,CD); the rectangle contained by thoſe two ſtraight Lines (AD and N) is equal to the rectangles contained by the undivided Line (N) and the ſeveral Parts (AB,BC, CD) of the divided Line (AD)

Hypotheſis.
AB *and* N *are two ſtraight Lines, one of which* AD *is divided in ſeveral Parts* AB, BC, CD.

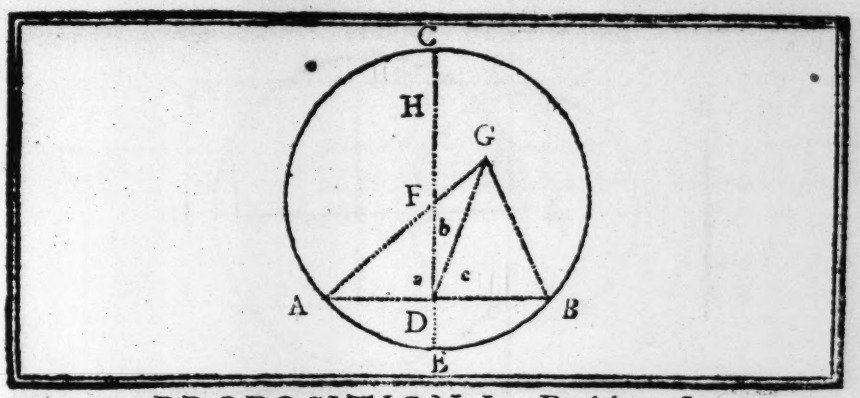
Theſis.
the Rgle. AD.N *is* = *to Rgles.* AB. N + BC. N + CD. N.

Preparation.

*P.*11 *B.*1 1. Upon AD at the Point A, raiſe the ⊥ A K.
P. 3 *B.*1 2. From the ſtraight Line AK, cut off a part EA=N.
3. Thro' the Points D and E, draw the ſtraight Lines DH, EH Plles. to AE, AD.
*P.*31 *B.*1 4. And thro' the Points of Section B and C, the ſtraight Lines B F, CG Plles. to AE or DH.

DEMONSTRATION.

*Ax.*1 *B.*2 1. The Rgle. AH is = to the Rgles. AF, BG, CH taken together.
But becauſe the Rgle. A H is contained by the ſtraight Lines EA, AD (*Prep* 3.) and that AE=N. (*Prep.* 2.)
*Ax.*2 *B.*2 2. This Rgle. AH is contained by the ſtraight Lines AD and N.
In like Manner, becauſe the Rgle. A F is contained by the ſtraight Lines EA, AB (*Prep* 4.) and that EA=N. (*Prep.* 2)
*Ax.*2 *B.*2 3. This Rgle. AF is contained by the Lines AB and N.
4. After the ſame Manner the Rgle B G is contained by BC and N, be-
*P.*34 *B.*1 cauſe it is contained by FB and BC, and that FB=N.
And ſo of all the others.
5. Therefore the rectangle contained by AD and N, is = to Rgles. contained by AB and N, BC and N, CD and N taken together, i. e. Rgle.
*Ax.*1 *B.*1 AD. N is = AB. N + BC. N + CD. N. Q.E.D.



PROPOSITION I. Problem I.

TO find the Center (F) of a given Circle (A C B E)

Given *the Circle* A C B E. — Sought *the Centre* F *of this* ⊙

Reſolution.

1. Draw the Chord A B. *Poſ.* 1
2. Biſect it in the Point D. *P.*10 *B.*1
3. From the Point D, raiſe upon AB the ⊥DC, and Produce it to E. *P.*11 *B.*1
4. Biſect C E in F. *P.*10 *B.*1

The Point F will be the Center ſought of the given ⊙ ACBE.

DEMONSTRATION.

If it be not. Some other Point,as H or G taken in the Line,or without. The Line EC, will be the Center ſought of ⊙ ACBE.

Caſe 1.

Suppoſing the Center to be in the Line EC at a Point H diff. from F. Since the Center of the ⊙is in the Line EC at a Point H diff. from F.

1. The Rays HE and HC are = to one another. *D.*15 *B.*1
   But FE being = to FC (Ref. 4) and H C ∠ FC. (*Ax.* 8 *B.* 1.)
2. HC will be alſo ∠ FE, and a Fortiori ∠ HE.
3. Therefore H E is not = to H C.
4. Conſequently the Point H taken in the Line E C different from the Point F, cannot be the Center of ⊙ ACBE.

Caſe 2.

Suppoſing the Center to be without the Line E C in G.

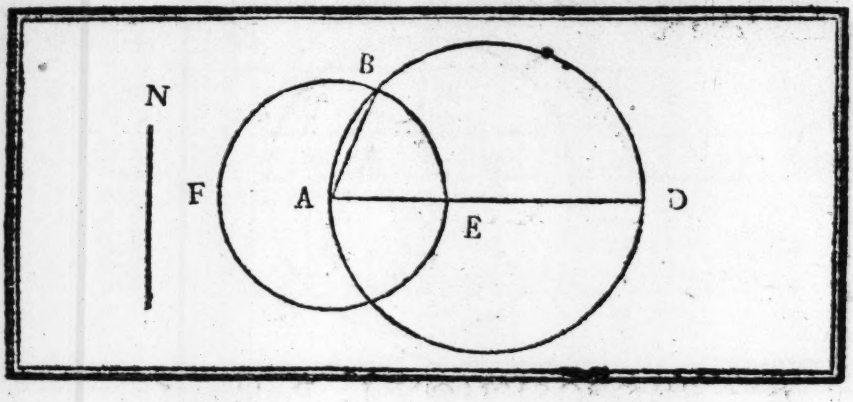
Preparation.

Draw from the Center G the Straight Lines GA, GD, GB. *Poſ.* 1.
Since in the △ A G D, D G B, the Side G A is = to the Side G B. (*Prep.* & *Def.* 15. *B.* 1.) The Side GD Common to the two △, and the baſe AD=to the baſe DB (*Ref.* 2.)

1. The adjacent ∀ a + b and c oppoſed to the equal Sides GA, GB are = to one another. *P.*8 *B.*1
2. Therefore ∀ a + b is ∟. *D.*10 *B.*1
   But ∀ a being alſo *a* ∟. (*Ref.* 3)
3. It follows that ∀ a + b is = to ∀ a which is impoſſible. *Ax.*8 *B.*1
4. Therefore the Point G taken without the Line E C, cannot be the Center of ⊙ A C B E.

Conſequently ſince the Center is not in a Line EC, at a Point H diff. from F, (*Caſe* 1.) nor without the Line EC in a Point G. (*Caſe* 2.)

5. The Center ſought of ⊙ ACBE, will be neceſſarily in F. Which was to be found.



PROPOSITION I. Problem I.

IN a given Circle (A B D) to place a ſtraight Line (A B) equal to a given ſtraight Line (N) not greater than the Diameter of the Circle (ABD)

Given.
a ⊙ ABD *with a ſtraight Line* N, *which is not* 7 *the Diameter of the* ⊙.

Sought.
a ſtraight Line AB *placed in a* ⊙ ABD, *and which is* = *to a ſtraight Line* N.

Reſolution.

Poſ. 1. 1. Draw the Diameter AD of the ⊙ ABD.

Caſe 1.

If AD is = to N.

We will have have placed in the given ⊙ ABD a ſtraight Line A D
*D.*7 *B.*4 = the given N.

Caſe 2.

If AD is 7 N.

P. 3 *B.* 1 1. Make AE = to N.

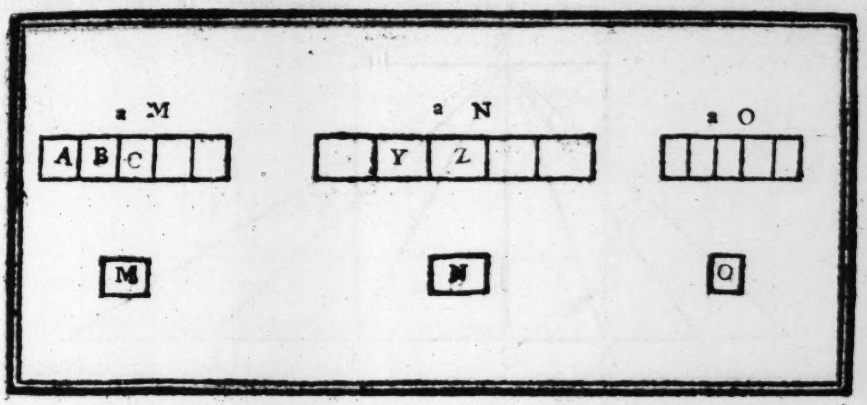
2. From the Center A, and with the Ray AE, deſcribe the ⊙ EBF, and
Poſ. 3. draw AB.

DEMONSTRATION.

Since AB is = to AE (*Def.* 15. *B.* 1.) and the ſtraight Line N is = to AE. (*Ref.* 1.)

Ax. 1. *B.* 1 } 1. The ſtraight Line AB placed in the ⊙ ABD will be alſo =
*D.*7 *E.*4 } to N.

Which was to be done.



PROPOSITION I. Theorem I.

IF any Number of Magnitudes (a M, a N, a O) be Equimultiples of as many (M, N, O, &c. each of each, the Sum (a M + a N + a O &c.) of the firſt will be the ſame Multiple of the Sum (M+N+O &c.) of the ſecond, as one of the firſt (a M) is of its Correſpondent (M)

Hypotheſis.	Theſis.
a M, a N, a O *are Equimultiples of* M, N, O *each each*	a M + a N + a O *is the ſame Multiple of* M + N + O *as* a M *is of* M *or* a N *of* N.

Preparation.

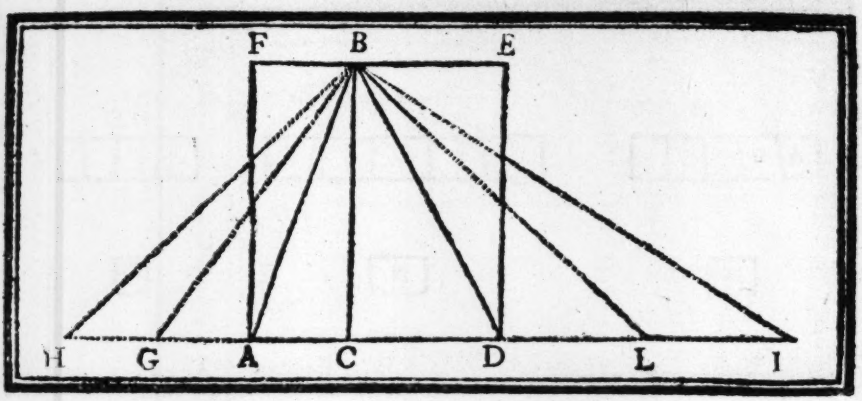
Becauſe a M is the ſame Multiple of M, as a N is of N (*Hyp.*) we can take out of a N ſo many Magnitudes X. Y Z, &c. each equal to its Correſpondent N, as we can take out of a M, A, B, C, &c. each equal to its Correſpondent M.

Make therefore A, B, C *equal each to* M *and* X, Y, Z *equal each to* N *Poſ. 2.*

DEMONSTRATION.

Since a M is the ſame Multiple of M, as a N is of N. (*Hyp.*)

1. a M ſhould contain as many Magnitudes A, B, C, &c. equal each to M, as a N contains equal to N, *viz.* X, Y, Z, &c.
   But A=M and X=N (*Prep.*)
2. Therefore A+X = M+N. *Ax. 2 B. 1*
   Alſo B being = M and Y=N (*Prep.*)
3. It follows that B+Y = M+N. *Ax. 2. B. 1*
   And ſince C=M and Z=N (*Prep.*)
4. We will have C+Z = M+N. *Ax. 2. B. 1*
   Conſequently there is in a M as many Magnitudes = M as there are in a M + a N Magnitudes = M + N.
5. Therefore a M + a N is the ſame Multiple of M + N as a M is of M, or that a N is of N, and for the ſame Reaſon a M + a N + a O is the ſame Multiple of M+N+O as a M is of M, or a N of N, &c. Q.E.D.



PROPOSITION I. Theorem I.

THE Triangles (ABC, CBD) and Paralelograms (CF, CE) which have the ſame Altitude, are to one another as their Baſes (AC, CD)

Hypotheſis. Theſis.

the △ ABC, CBD *and Pgmes.* 1. *The* △ ABC : △ CBD = AC : CD
CF, CE *have the ſame Altitude.* 2. *The Pgme.* CF: *Pgme.* CE :: AC : CD.

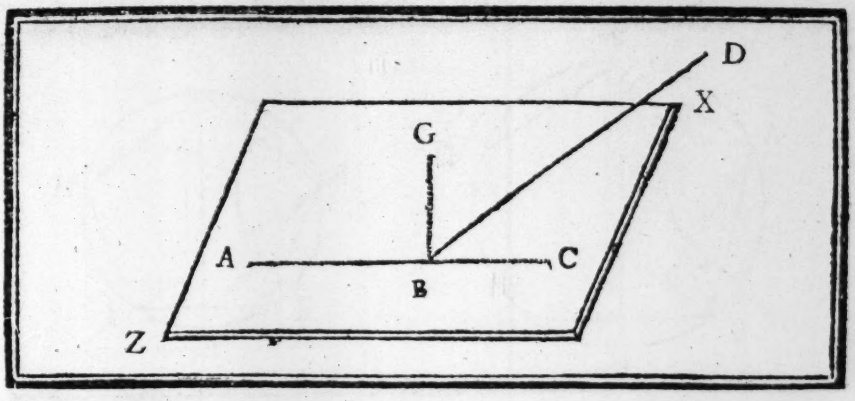
Preparation.

*Poſ.*2 *B.*1. 1. Produce AD both ways to the Points H and I.
*P.*3 *B.*1 2. Make AG = AC = GH alſo DL = CD = LI.
*Poſ.*1 *B.*1 3. Draw BG, BH, BL, BI.

DEMONSTRATION.

Becauſe the △ ABC, GBA, HBG are upon equal Baſes AC, AG, GH *(Prep.* 2.) and between the ſame Plles. HI, FE, *Hyp. & Def.* 35. *B.* 1. *& Rem. Def.* 4 *B.* 6.)

*P.*38 *B.*1 1. Thoſe △ are = to one another.
2. Therefore the △ HBC, and the Baſe HC are Equimultiples of △ ABC, and of the Baſe AC.
For the ſame Reaſon,
3. The △ CBI, and the Baſe CI are Equimultiples of △ CBD, and of the Baſe CD.
4. Conſequently the Magnitudes HBC and HC, are Equimultiples of the Magnitudes ABC and AC, *(Ax.* 2.) and the Magnitudes CBI and CI are Equimultiples of the Magnitudes CBD and CD *(Ax.* 3.)
But if the △ HBC is 7 = or ∠ △ CBI, the Baſe HC is alſo 7, = or ∠ than the Baſe CI. *(Prop.* 38. *B.* 1.)
*D.*5 *B.*5 5. Therefore the △ ABC : △ CBD = AC : CD. Q. E. D. 1
Becauſe the △ ACB, CBD are the halfs of the Pgmes. CF, CE. *(Prop.* 41. *B.* 1.)
*P.*15 *B.*5 6 It follows that △. ACB : △ CBD = Pgme. CF : Pgme. CE.
*P.*11 *B.*5 7. Therefore the Pgme. CF : Pgme. CE = AC : CD. Q. E. D. 2.



PROPOSITION I. Theorem I.

IF one Part (AB) of a ſtraight Line is in a Plane (ZX) the other Part will be in the ſame Plane.

Hypotheſis.
AB *is a Part of a ſtraight Line ſituated in the Plane* ZK.

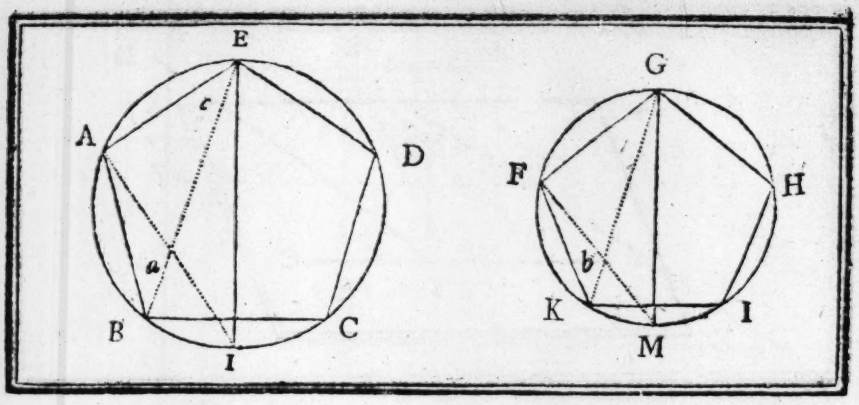
Theſis.
The other Part of the ſtraight Line (*as* BC) *will be in the ſame Plane* ZX.

DEMONSTRATION.

If not
It will be above the Plane as BD is.

Preparation.

1 Upon AB at the Point B raiſe in the Plane ZX the ⊥ GB. *P.* 11 *B.* 1.
2 Upon BG at the ſame Point B in the Plane ZX raiſe the ⊥ BC.
Since ∀ ABG is ∟, as alſo ∀ GBC concurring in the ſame Point B.
1 The Lines AB and BC are in one, and the ſame ſtraight Line AC. *P.* 14 *B.* 1.
Notwithſtanding the Line BD is a Part of the ſtraight Line ſituated above the Plane. *(Sup.)*
2 Therefore the Lines BD and BC have a common Segment AB.
3 Which is impoſſible. *Cor.* 11 *B.* 1
4 Therefore BD cannot be a Part of the right Line AB.
5 Therefore one Part of a ſtraight Line cannot be in a Plane, and another Part above it. Q. E. D.



PROPOSITION I. Theorem I.

THE ſimilar Poligons (ABCDE and FGHIK) inſcribed in Circles, are to one another as the Squares deſcribed upon the Diameters (EI and GM) of thoſe ſame Circles.

Hypotheſis.	Theſis.
1 *The Polygons* ABCDE and FGHIK *are ſimilar.*	*Polygon* ACE : *Polygon* FIH = *the* □ *upon the Diameter* E I *is to* □ *upon the Diameter* GM *or as* $EI^2 : GM^2$.
2 *They are inſcribed in Circles.*	

Preparation.

Poſ. 1 *b.* 1
1 In the ⊙ACD, draw AI and BE alſo the Diameter EI.
2 In the ⊙FMH, draw the Homologus Lines FM and GK. Alſo the Diameter GM.

DEMONSTRATION.

Since the Polygons ABCDE and GFKIH are ſimilar *(Hyp.* 1.*)* the Angle A or EAB is = to ∀GFK, and AE : AB = FG : FK. *(D.* 1. *B.* 6)

P. 6. *b.* 6
1 The △AIE is Equiangular with △FGK.
2 Therefore △ABE is ſimilar to △GFK and ∀a = ∀b alſo ∀c = ∀d but ∀EIA is = to ∀EBA or *a*, and ∀GMF = ∀GKF or *b*.
3 Conſequently ∀EIA is = to ∀GMF.
4 For the ſame reaſon ∀EAI = ∀GFM.
And ſince in the two △ AIE and GFM, the two ∀ EIA and EAI of the firſt, are Equal to the two ∀GMF and GFM of the ſecond. *(Arg.* 3 & 4*)*
5 The third ∀AEI of △EAI will be = to the third ∀FGM of the△ FMG.
6 Therefore EI : AE = GM : GF.
P. 22 *b.* 5
7 Alternating EI : GM = AE : GF and $EI^2 : GM^2 :: AE^2 : GF^2$.
But AE and GF are the Homologus ſides of the Polygons A D B and FHK.
Moreover E I and G M are the Diameters of the ⊙ in which the Polygons are inſcribed.
P. 20 *b.* 6
8 Therefore Polygon ABCDE : Polygon FKIHG = $EI^2 : GM^2$. Q.E.D